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the Petroleum Engineer

FOR MANAGEMENT

DECEMBER 1958

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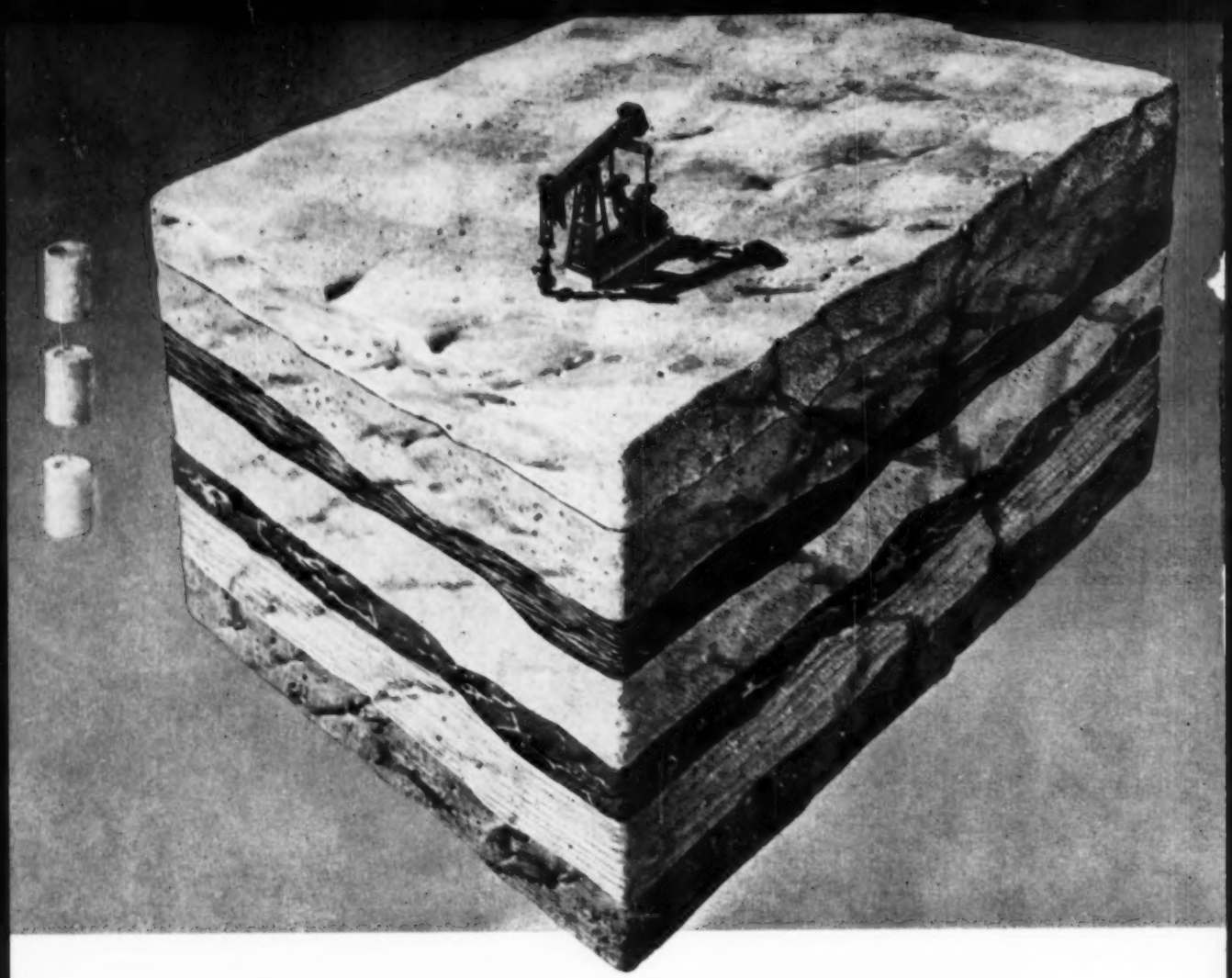

Could this be your marginal well?

If you're operating a marginal well, this illustration could be a portrait of that well. Close examination of your well logs may reveal additional zones of potential productivity and a chance for increased production—with the *right* acidizing or fracturing treatment.

Here, for example, are three adjacent oil-saturated intervals within a single section. They have dissimilar porosities, permeabilities, and acid solubilities. Production from any *one* interval would not pay out; from *two* would be marginal, but from *all three* would make a good commercial well.

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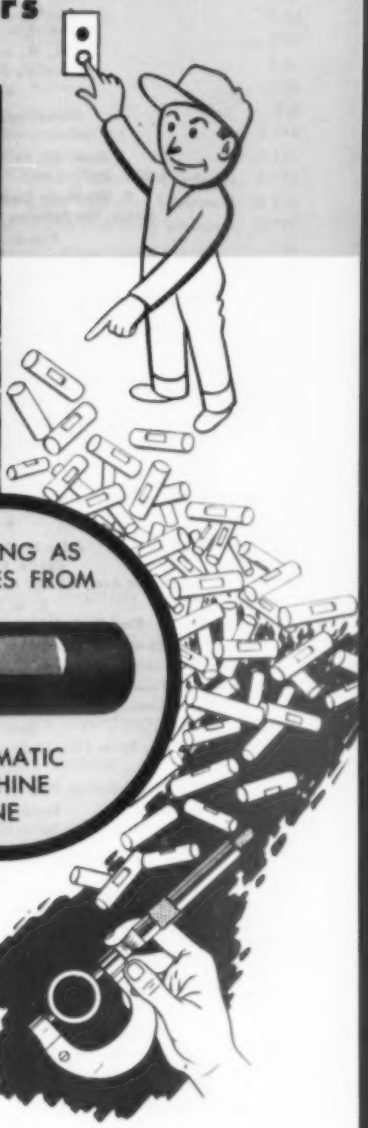
makes Sucker Rod Couplings on Push-button Orders



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Bad officials are elected by good citizens who don't vote.
— *George Jean Nathan*

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Our Last Free Choice

THE STUNNING victory of many left-wing politicos in the national November election may be the Sputnik needed to inspire opposition. Those who prefer to conserve the most successful system of government and economics ever devised may be forced into aggressive campaigning.

The key word here is "prefer." Preference must be transformed into determination. The answer of the voters to weak and divided conservative forces is "Put up or shut up."

The national petroleum industry will be on the legislative spot often in the next two years. Without unity of purpose we could come out in 1960 with FPC control of oil as well as gas. Election results convince us that only the most powerful defense by the whole industry can avert a downward revision of the 27½ percentage depletion in the next Congress.

The industry fight over voluntary vs mandatory controls of imports will be swallowed in the demand for price control of oil products similar to price control of natural gas.

If, as Congressman Gwinn stated (November's Course of Oil), the last Congress was dominated by members elected through labor union influence, this one will be much more so. What labor union leaders want will tell us, to a large extent, what we will get.

They want more government spending, less income taxes on lower incomes, breaking up of large business corporations; they want rent control, direct price control of basic commodities (oil and gas, etc.), federal review of proposed price increases, government incorporation of business enterprises, federal government financing of education and medical care. (Testimony released November 9 by Senate-House Economic Committee.) They want socialism wrapped up in the sheep's clothing of "people's capitalism."

But inflation, the wolf, is always there to eat the worker's wages and his pension. Government deficit spending and spiraling of costs — much of it due to forced wage increases — can be met only by inflation. Inarticulate conservatives have never driven this elementary point home. More often than not they are the sheep, posing as wolves from tragic ineptness.

We have a choice — perhaps our last free choice — Do we fight for limited government and freedom of economic enterprise as the colonists once did, or do we join "the oil and gas for all the people" (with not much for any but government officials) side?

It would be easier and, temporarily, more profitable to get in the left-wing swing. We could very probably get subsidies for unprofitable oil properties and for withholding good potential production.

But consumers would pay. The nation would pay — as it is beginning to now — in lack of responsibility, and in decadence of integrity and leadership. It will take unswerving courage and heartbreaking work to turn the tide.

We are eating cake. Have we the strength to choose bread?

Ernestine Adams

Congrats and $25 to Mr. D. J. SUGGS, Republic Natural Gas Co., Tipton Bldg., Pauls Valley, Okla., for this quip.

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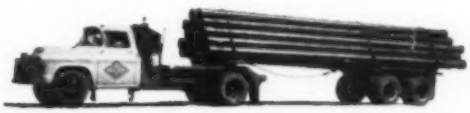

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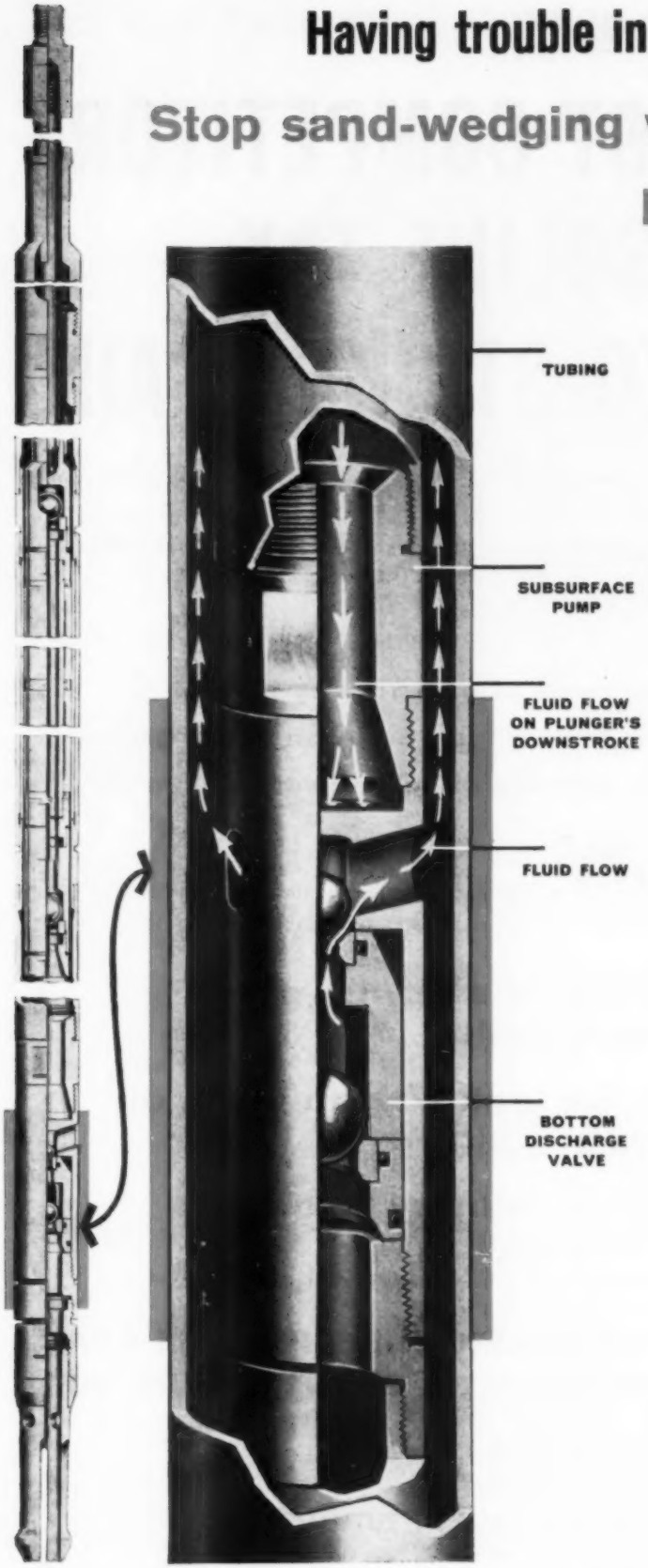
THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS — THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS

Having trouble in sandy wells?

Stop sand-wedging with an "Oilwell" Bottom Discharge Valve!



Bottom-seated rod pumps frequently become wedged in the tubing when sand accumulates between pump barrel and the tubing. This necessitates pulling a "wet" tubing string which is a troublesome and costly operation.

An "Oilwell" Bottom Discharge Valve in your pump relieves your mind of this worry, by its unique discharge action. On the down strokes of the plunger, fluid is discharged in ample volume to prevent sand, paraffin or other debris from settling around the base of the pump. Even when the pump resumes action after shutdowns, sand deposits are quickly washed away.

The Pump Specialist at your nearest "Oilwell" store will be glad to explain further, not only how the Bottom Discharge Valve works, but also why it works so well. It is typical of the many advanced features that "Oilwell" Engineers have designed to keep your subsurface pumps operating at highest efficiency and lowest cost.

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Warning to all oilmen!

YOUR BIGGEST COMPETITOR— THE GASOLINE TAX— IS READY TO STRIKE AGAIN!

As every oilman knows, gasoline taxes are your biggest competitor for the American motorist's gasoline dollar.

Now, according to reports from Washington, Congress will be asked to raise the federal gasoline tax again—by as much as *2¢ on every gallon!*

TODAY: The American motorist pays federal and state gasoline taxes* equal to:

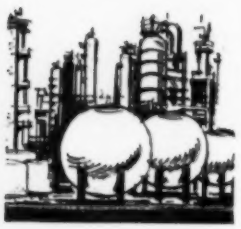
41% of the retail price on every gallon

54% of the tank wagon price on every gallon

80% of the refinery price on every gallon

TOMORROW: If this tax increase is allowed to go into effect, the American motorist will pay federal and state gasoline taxes* equal to:

50% of the retail price on every gallon



66% of the tank wagon price on every gallon

97% of the refinery price on every gallon

*Combined national average of state and federal gasoline taxes.

WHAT DO YOU THINK THE AMERICAN PEOPLE WILL SAY ABOUT THIS? CAN THEY AFFORD IT? WILL THEY BLAME YOU?

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$90,000,000
LARGEST
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ADDED STRENGTH YOU CAN BANK ON

THE CONFERENCE TABLE

Bad officials are elected by good citizens who do not vote . . . GEORGE JEAN NATHAN

Political Action by Industry

Frank M. Porter, president of API, said in his address to the national convention in November that if we are to win the political battle, we must throw ourselves into the struggle "that will decide with finality the career of every man and woman in this room." This statement of conditions is one we have not faced. We are traveling willy-nilly into the wilderness of bureaucratic rule without looking at the map.

"The outlook is as gloomy today as it has ever been in my 42 years of association with the petroleum industry" Porter said.

A number of papers at the API convention went into the political and public relations aspects of the present situation. Unless the oil industry improves its public relations it is in for real trouble, Lyle C. Wilson, vice president and manager of Washington Bureau of United Press International, told the convention. Wilson pointed out that 13 new senators were elected in November and most or all will be against the oil industry unless somebody tells the industry story better than it has been told in the past. Wilson also mentioned a point in the organization of public relations that is seldom discussed outside of individual companies. He urged oil company executives who do not have their public relations men reporting directly to the top to change their set up. Public relations, he said, begins at the top. In our long years in dealing with company public relations men, we have gained substantial proof that this is true and only in rare cases does a public relations department function unless it is part of top management.

Recipient of the API Gold Medal for Distinguished Achievement, W. S. S. Rodgers, warned that oil industry's internal disputes might lead to increased Federal regulations of the entire industry. Senator Lyndon Johnson and Congressman Harris are two legislators who have previously told the industry it is courting further domination by the Federal government.

This cartoon by Holland (Chicago Tribune Syndicate) ran in the Tulsa World.

The editor of the Cleveland, Ohio, *Press* told oil men "In dealing with the public in the sale of products at retail you have achieved a singular cordiality because you do a splendid job of serving the public and present a picture of orderliness and service."

Then Louis B. Seltzer said "on the higher echelon of politics you are in very real trouble. You have been stupid and arrogant and unmindful of the inevitable results of your conduct. I cannot understand why an industry so great, so rich, and so progressive permits so much to be done in its name."

Seltzer added, "You are now the scapegoat of American emotionalism." Seltzer declared that all business and industry must pay more attention to public affairs if the nation is to be preserved as a free democracy.

On the positive side, after all the "viewing with alarm," there was a plea for unglamorized work and cooperation for the API Committee on Public Affairs. The consolidation of Oil Information Committee and American Petroleum Industries Committee evidently had approval.

In his acceptance speech, Rodgers said he was happy to be attending the meeting at which the Committee on Public Affairs was formed. "I feel that this is a most important step on the part of the industry" he said. "And that the proper support for and participation in this organization is the responsibility of each company and each person who derives his livelihood from the petroleum business."

Kerryn King, chairman of API Committee on Public Affairs (and vice president of The Texas Company) went into the purpose of this new committee. He said there were problems that would always be with the industry and that no organization, no matter how effective and dedicated it may be, can hope to solve them.

"The very most we can hope to provide is (1) A forum for intelligent discussion and analysis of these matters and (2) A medium through which people in this industry can work together in dealing with them."

He frankly admitted the whole program could fall flat on its face. All that would be needed to insure the result would be for individuals and companies to sit back with a comfortable thought that the Committee on Public Affairs would have everything well in hand. To a large degree this has been what the API public relations committees have always found to be their greatest bugaboo.

If the new committee can inspire the industry to work, if it can make the individual realize that part of the problem sits on his shoulders and cannot be shared, if it can break down any part of the iron divisions in our industry —if it can do these things it will be the greatest accomplishment we have yet achieved.

Fringes Fly High

Fringe benefits cost petroleum industry $1650 per year for each worker. The petroleum industry has substantially more benefits than any other. In the two years from 1955 to 1957 costs increased from 61 cents per payroll hour to 78 cents for employee benefits.

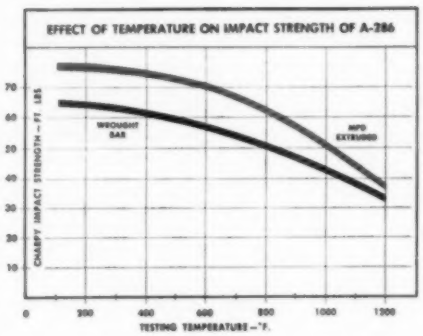
(Continued on Page A-23)

EXTRUSION • CASTING • FORGING • FABRICATION

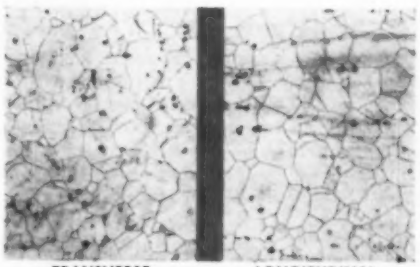
CURMET

Metals shaped under Micro Controls

From melt to finished product, steel and other premium alloys are under constant, critical surveillance at the Metals Processing Division of Curtiss-Wright Corporation. CURMET commercial products have the same built-in precision qualities that have steadily surpassed rigid military and commercial specifications for many years.



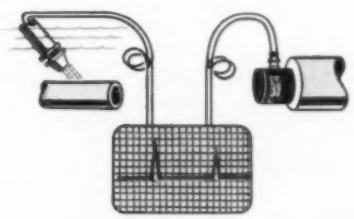
CURMET quality is more than inspection . . . though the most modern flaw detection methods are employed . . . it is the *in-process control of metal flow* that imparts premium properties and adds to service life.



TRANSVERSE LONGITUDINAL

CURMET processing with accurate metallurgical control is typified by this microphoto of a precipitation hardening, high temperature alloy extrusion (A-286) showing uniform longitudinal and transverse grains. Metallurgical examination of the extrusion shows uniformity of microstructure, assuring consistently high mechanical properties throughout the full length.

ULTRASONIC INSPECTION



IMMERSION TESTING — OR — CONTACT TESTING

Permissible ultrasonic flaw indication for commercial products is 5% of wall thickness. Nuclear applications are specified at 3%. High-performance A-286 alloy, when CURMET processed, consistently passes ultrasonic testing at the 1½% level . . . with no defects noted even under these rigid test conditions.

CURMET ultrasonic testing can be applied to your forged or extruded product by either the immersion or contact method. Simple or complex, solid or hollow, your product gains quality by CURMET in-process control.

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HIGHLIGHTS

★ ★ ★

Digest of News and Comments

API Officers for 1959

H. S. M. Burns, president of Shell Oil, and Frank M. Porter, president of Fain-Porter Drilling Company, Oklahoma City, Oklahoma, were re-elected chairman of the board and president of the American Petroleum Institute, respectively, at the association's 38th annual meeting.

Newly-elected vice presidents are: L. E. Fitzjarrald, manager of the production department, Phillips Petroleum, API vice president for production; Clarence H. Thayer, vice president of Sun Oil, API vice president for refining; C. J. Guzzo, vice president of Gulf, API vice president for marketing; W. J. Arnold, assistant vice president, Pure Oil, was elected API vice president for finance and accounting.

Re-elected vice president was C. E. Spahr, president of The Standard Oil Co. (Ohio), API vice president for transportation.

P. C. Spencer, chairman of the board of Sinclair, was re-elected treasurer, and Williard M. Wilson was re-elected secretary.

Oil Stamp to Be Issued

A special commemorative stamp will be issued next year to mark the centennial of the U. S. oil industry, the API was advised by the Post Office Department. Stamp will be issued at Titusville, Pennsylvania, on August 27, 1959 — accepted home of the American oil industry, and 100 years to the day that the first commercial oil well became a reality. The color, size and denomination of the stamp has not been announced.

Producing Properties Acquires Oceanic

Producing Properties, Inc., of Dallas, Texas, has contracted to acquire all assets of Oceanic Oil Company of Los Angeles, California. Oceanic Oil will be liquidated under terms of an agreement by both boards of directors, and a new issue of Producing Properties common will be distributed to present Oceanic stockholders.

The acquisition is the 39th consecutive purchase by the Texas firm since it was founded 3½ years ago. Oceanic properties include 231 producing wells, two waterflood projects and 250,000 acres of undeveloped acreage in the U. S. and Alaska.

Sinclair, BP in Trade Agreement

Sinclair Oil Corporation and British Petroleum Company have entered into a three-part agreement involving supply, production and marketing of crude oil between the Eastern and Western Hemispheres. The non-exclusive pact would permit Sinclair to make use of Persian Gulf crudes that BP does not now have a market for. Also, a new company would be created to market Middle East and Venezuelan crude. Another jointly-owned company would be established to provide for exploration and production ventures, primarily in South America.

Burns Named 'Congress' President

H. S. M. Burns, president of Shell Oil Company and chairman of the board of directors of the American Petroleum Institute, has accepted the presidency of the 1959 World Petroleum Congress. As Congress president, Burns will preside at the more important functions planned for the meeting, scheduled for New York, May 30-June 5.

Jake Hamon Gets New Award

The new Carl A. Young Memorial Award has been given to Jake L. Hamon, Dallas, Texas, independent producer. Award was made to Hamon by the API Division of Production at the 38th annual convention in Chicago. Citation was for his "exceptionally meritorious service to the petroleum industry over the past 22 years." Hamon was API chairman in 1956 and 1957 and served two terms as vice president for the Division of Production in 1947 and 1948.

States Refile Tidelands Brief

Five Southern states have presented a new Supreme Court brief in which they consider the views of Secretary of State John Foster Dulles as "unnecessary" in deciding the offshore boundary dispute. Louisiana, Texas, Mississippi, Alabama, and Florida filed the joint brief, which was made public by Louisiana Attorney General Jack Gremillion. The Supreme Court recently cancelled oral arguments in the controversy involving the 3 to 10-mile limit of state or federal tidelands ownership.

Companies to Keep Service Stations

U. S. district court in San Diego, California, has ruled that seven West Coast oil companies may keep their retail service station outlets. The ruling, affecting Standard of California, Union of California, Shell, Tidewater, Texaco, General Petroleum, and Richfield, also reset an anti-trust pre-trial discussion date for February 3 for the companies and the government to reach some compromise in the eight-year-old suit. The government had asked that the group completely divest themselves, over a five-year period, of all retail outlets. The court, in ruling out the government's plea, suggested that the oil companies had corrected alleged abuses prior to this time.

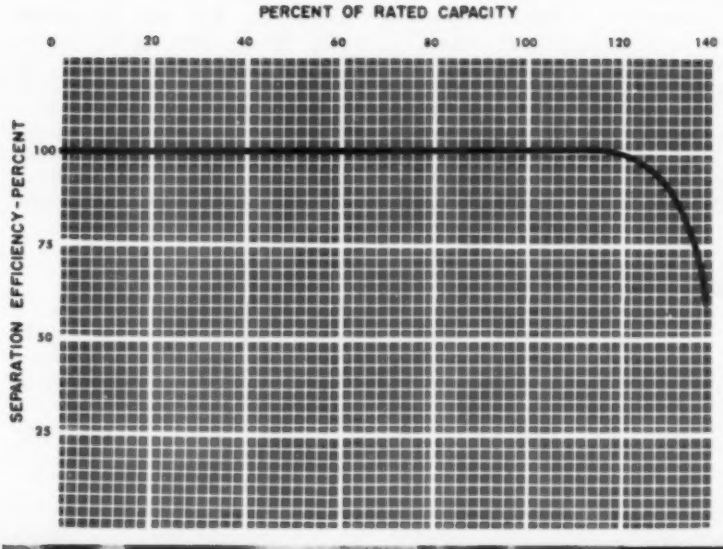
Texaco Is Leading U. S. Producer

The Texas Company is now the largest crude oil producer in the U. S., with a gross domestic production now running at approximately 480,000 bbl a day, reports Augustus C. Long, Texaco board chairman. Long points out that the U. S. is now consuming seven times as much oil as was found here in new discoveries.

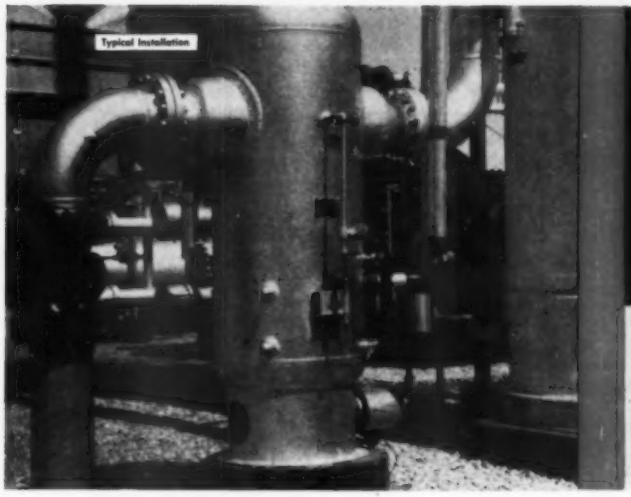
PE Elects New Vice President

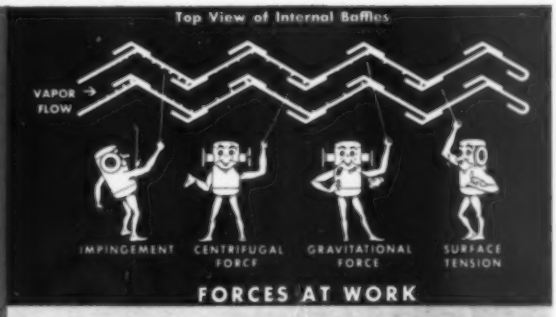
The PETROLEUM ENGINEER Publishing Company announces the election of E. V. (Cy) Perkins as a vice president. Perkins, previously district manager with offices in Chicago, has been associated with the organization since 1938. In his new capacity he will continue to represent the company's five publications in seven midwestern states and central Canada at his Chicago headquarters.

FLAT EFFICIENCY CURVE with PEERLESS Separators...



with Peerless Separators you can remove entrained liquids from process vapor lines and maintain a high efficiency over the entire range of flow.





FORCES AT WORK

The above illustration shows a top view looking down at two of the many internal separator baffles. Entrained liquid droplets are caught in the pockets and drained down out of the gas flow . . . thereby completely stripping the gas before it leaves the mist extractor.

PEERLESS MFG. CO. DALLAS, TEXAS

PEERLESS MANUFACTURING COMPANY

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OTHER OUTSTANDING FEATURES OF PEERLESS SEPARATORS

- **Low pressure drop across mist extractor — less than 6" of water.**
- **Compact and economical.**
- **Vane units can be made easily removable.**
- **Mist extractor and vessel can be made of any type material. Carbon steel mist extractors can be placed in a vessel and stress relieved without damage.**
- **Can be designed for any capacity or special requirement.**

OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE

PE Founder Dies

Thomas Joseph Crowley, Sr., 64, former publisher and one of the founders of The Petroleum Engineer Publishing Company, died October 13 after a short illness.

Mr. Crowley was born in Brooklyn, New York, and moved to Tulsa, Oklahoma, in 1919, where he was associated with the *Oil and Gas Journal*. In 1929 he helped organize *The Petroleum Engineer* Publishing Company with which he was connected until his retirement in 1954. More recently he has been vice president of Oildom Publishing Company, Bayonne, New Jersey.

Oklahoma Oil Price Changing

Both upward and downward price adjustments of Oklahoma, Kansas, and North Texas crudes affected production and purchasing throughout most of October and November. At one stage early in November, the drastic revision of crude purchasing methods resulted in seven different price postings in Oklahoma and six in Kansas. Nearly all Oklahoma oil dropped from a previous high of $3.15 per bbl to a peak fluctuating between $3.01 and $3.08. Many purchasers involved and rapid changes resulted in various and sundry gravity differential postings. The changes were first made in Oklahoma in October and attention switching to Kansas early in November. Sunray Mid-Continent, largest single buyer of Oklahoma crude, began the shifting in October by dropping its top price from $3.15 to $3.01; this price was raised to $3.08 in November. Most purchasers have settled on one of two tops: Either $3.08 as set by Sunray Mid-Continent, or a $3.05 high established by Magnolia and Sinclair.

Conservation Forum Organized

Five regional subcommittees were formed at an initial meeting of the steering committee of the new Oil Industry Conservation Forum. The business meeting in Houston recently brought forth several suggestions relative to conservation advances. Steering committee chairman is Jake Hamon, independent of Dallas; chairman of the forum is E. B. Miller Jr., Tidewater Oil Company. J. U. Teague, Columbia Drilling Company and past president of AAODC, was appointed vice chairman of the new organization. Nearly all comments received by the new group suggest wider well spacing.

Gasoline Tax Revenues Up

Gasoline tax collection by the Federal Government reached a total of $1,636,629,000 in the fiscal year 1958, which ended June 30. This is an increase of $200 million over the previous fiscal year. Tax revenue for lubricating oil and cutting oil was almost $70 million during the 1958 fiscal year, down from $73.6 million high of the previous tax collection year.

Texas Hikes Allowable

Texas Railroad Commission's order for 12-day permissive oil flow in December raised the daily production rate to 3,147,506 bbl per day. Although higher than the 11-day rate in November and above the allowable set for last December, the commission closed the year with the lowest total producing days' record in Texas oil history. The 12-day pattern gives Texas a total of 122 producing days—down 49 days from the 171 day schedule in 1957. In 1952 the state produced oil on a 259-day schedule.

Meetings

1959

Jan. 12-16—**SAE** annual meeting and engineering display, The Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

Jan. 19-22—**American Road Builders Assn.**, 57th annual convention, Dallas, Texas.

Jan. 23—**NGAA**, Oklahoma regional meeting, Biltmore Hotel, Oklahoma City, Okla.

Jan. 26-29—**Plant Maintenance & Engineering Show**, Public Auditorium, Cleveland, Ohio.

Feb. 1-4—**AAPG**, Rocky Mountain Section, 9th annual meeting, Civic Auditorium, Albuquerque, N. Mex.

Feb. 9-11—**AAPG**, Rocky Mountain Section, 9th annual meeting, Civic Auditorium, Albuquerque, N. M.

Feb. 11-13—**NACE**, Tulsa Section, annual pipeline corrosion short course, Tulsa, Okla.

Feb. 15-19—**AIME**, annual meeting, Sir Francis Drake Hotel, San Francisco, Calif.

Feb. 16-19—**AAPG-SEPM**, 44th annual meeting, Memorial Auditorium, Dallas, Tex.

Mar. 1-5—**ASME**, gas turbine power conference & exhibit, Netherlands-Hilton Hotel, Cincinnati, O.

Mar. 4-6—**API**, southwestern district meeting, Scharbauer Hotel, Midland, Tex.

Mar. 16-18—**WPRA**, 47th annual meeting, Hilton Hotel, San Antonio, Tex.

Mar. 16-20—**AIChe**, Chalfonte Haddon Hall, Atlantic City, N. J.

Mar. 16-20—**NACE**, 15th annual conference and exhibition, Sherman Hotel, Chicago, Ill.

Mar. 17-19—**NACE**, 1959 Corrosion Show, Sherman Hotel, Chicago, Ill.

Mar. 25-27—**API Division of Production**, southern district meeting, Roosevelt Hotel, New Orleans, La.

Mar. 31-Apr. 1-2—**Illinois Institute of Technology**, 21st American power conference, Hotel Sherman, Chicago, Ill.

Apr. 2-3—**Society of Petroleum Engineers of AIME, Rocky Mountain petroleum section**, 5th annual joint meeting, Casper, Wyo.

Apr. 5-9—**The 1959 Nuclear Congress**, Cleveland Auditorium, Cleveland, O.

Apr. 6-7—**Instrument Society of America**, 2nd National Symposium on Chemical & Petroleum Instrumentation, St. Louis, Mo.

Apr. 8-10—**API Division of Production**, eastern district meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 15-17—**National Petroleum Assn.**, semi-annual meeting, Hotel Cleveland, Cleveland, O.

Apr. 19-23—**ASME**, oil and gas power conference & exhibit, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 22-24—**API Division of Production**, mid-continent district meeting, Herring Hotel, Amarillo, Tex.

Apr. 30-May 1—**API Division of Production**, Pacific Coast district meeting, Biltmore Hotel, Los Angeles, Calif.

May 4-8—**API Safety & Fire Protection Committees**, 12th midyear meeting, Rice Hotel, Houston, Texas.

May 5-6—**AIME**, North Texas section, third biennial secondary recovery symposium, Wichita Falls, Tex.

May 6-8—**API Division of Production**, Rocky Mountain district meeting, Gladstone, Henning and Townsend hotels, Casper, Wyo.

May 7-8—**Society of Petroleum Engineers of AIME**, Permian Basin oil recovery conference, Midland, Texas.

May 15-24—**International Petroleum Exposition**, Tulsa, Okla.

May 17—**ASTM**, committee E-14, Statler Hilton Hotel, Los Angeles, Calif.

May 27-30—**API Division of Refining**, midyear meeting, Statler Hotel, New York City, N.Y.

May 30-June 6—**Fifth World Petroleum Congress**, Coliseum, New York City, N. Y.

Good Wells Make Good News

A Monthly Report of Successful Well Treatments

December 1958

Of all the fracturing services offered by Dowell, there are several reasons why Sandfrac® is one of the most popular. Net cost is low because the lease crude or refined oil used as the fracturing fluid can usually be sold with well production. Reliability is high because emulsion, water block and silicate swelling problems are kept to a minimum. Most important, results have been generally excellent and payouts have been fast. Here are four recent jobs that illustrate types of wells especially suited to Sandfrac.

- **Ochiltree County, Texas Panhandle.** (New Oil Well) This well was completed in the upper Morrow sand of the Farnsworth pool through perforations from 7930 to 7940 feet. Dowell recommended Sandfrac using lease crude on the basis of tests run on formation samples and on the field crude. The treatment was designed to give the operator good results with freedom from emulsions and clean-up troubles. 95 barrels of lease oil carrying 6000 pounds sand were pumped down casing and into the pay at 19 bpm. *After clean-up, well produced 39 bopb on Railroad Commission Test.*

- **San Juan County, New Mexico.** (New Gas Well) This well was completed through perforations from 6236 to 6248 feet into the Gallup sand. Initial production was a non-commercial 5 mcfd. Operator ordered Sandfrac. Dowell injected 19,000 gallons lease oil with 19,000 pounds sand and 45 perforation ball sealers. Average injection rate was 47.6 bpm with a maximum treating pressure of 3600 psi. *After treatment, well tested 43,193 mcfd.*

- **Loving County, Texas.** (Old Oil Well) This well was originally completed with nitro shots in the Delaware sand at 4335 feet. Production had declined to 8 bopd, so the operator ordered Sandfrac. 10,000 gallons lease crude carrying 15,000 pounds sand was injected at 30 bpm and 1300 psi. Total cost for Dowell service to operator was only $1670. *After clean-up, well tested 350 bopd.*

- **Garvin County, Oklahoma.** (New Oil Well) This well was completed in the Bromide sand of the East Antioch pool. Perforations were from 5602 to 5678 feet. Since well would not produce without stimulation, operator ordered Sandfrac. Dowell injected 10,000 gallons refined oil with 10,000 pounds sand and 100 pounds of temporary plugging agent. Injection was down 2½-inch tubing at 5200 psi and 8 bpm. 10 gallons Freflo® was used to aid in clean-up. *After treatment, well flowed 240 bopd on test.*

For more detailed information or prompt service, call any of the 165 Dowell offices and service points. In Canada, call Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Or write Dowell, Tulsa 1, Oklahoma.

Services for the oil industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

NEW DESIGNS IN CATERPILLAR EQUIPMENT AND PARTS DEPEND ON CREATIVE USE OF HIGHEST QUALITY STEEL

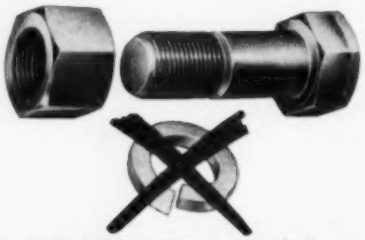
Example: Track hardware, made of stronger pre-tested steel and "Hi-Electro" hardened, stays tight without lock washers, often lasts through two sets of shoes

How much does it cost to pull a tractor off a job to tighten or replace track hardware? It costs plenty, in down time and in service time. That's why Caterpillar's new track hardware is such a good investment.

Caterpillar hardware normally stays tight without the use of lock washers throughout the service life of the first set of track shoes. And, exclusive "Hi-Electro" hardening of dome-shaped bolt heads often permits bolts to be used for a second set of shoes.

Most track hardware looks pretty much alike, but there's a big difference in quality. Steel, for instance. All steel for Caterpillar's new track bolts has a minimum tensile strength of 151,000 pounds per square inch, well above the SAE standard of 120,000-140,000.

The special steel accepted for track hardware is furnace-heated, quenched and tempered to toughen the entire bolt against breaking,



ELIMINATION of lock washer is feature of Caterpillar's new track hardware.

bending and the permanent stretching that leads to loosening of the nut.

Carbon, lost from the surface area in mill rolling and heat treating, is restored by Caterpillar with a carefully controlled, carbon-atmosphere process. Then threads are "rolled" into the bolt, curving the natural flow lines to follow the thread contours, producing threads that are highly resistant to stripping.

The large dome-shaped head receives an exclusive deep and even "Hi-Electro" hardening. This protects the hexagonal corners from mushrooming. Wrenches fit onto Cat bolts after many hundreds of hours of hard use.

This same quality of material, design and manufacture is found in *all* Caterpillar parts. And they're always available at your Caterpillar Dealer. See him today.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

SERVICE TIP

A torque wrench should always be used to tighten track hardware to factory-recommended torque values. Your Operating and Maintenance Instructions give exact values for each tractor model.

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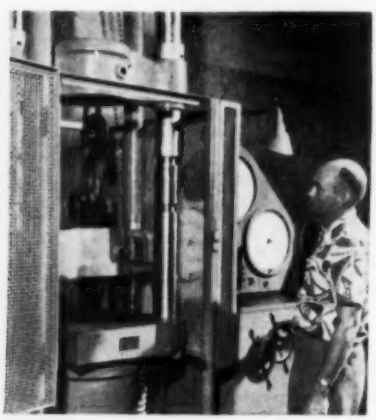
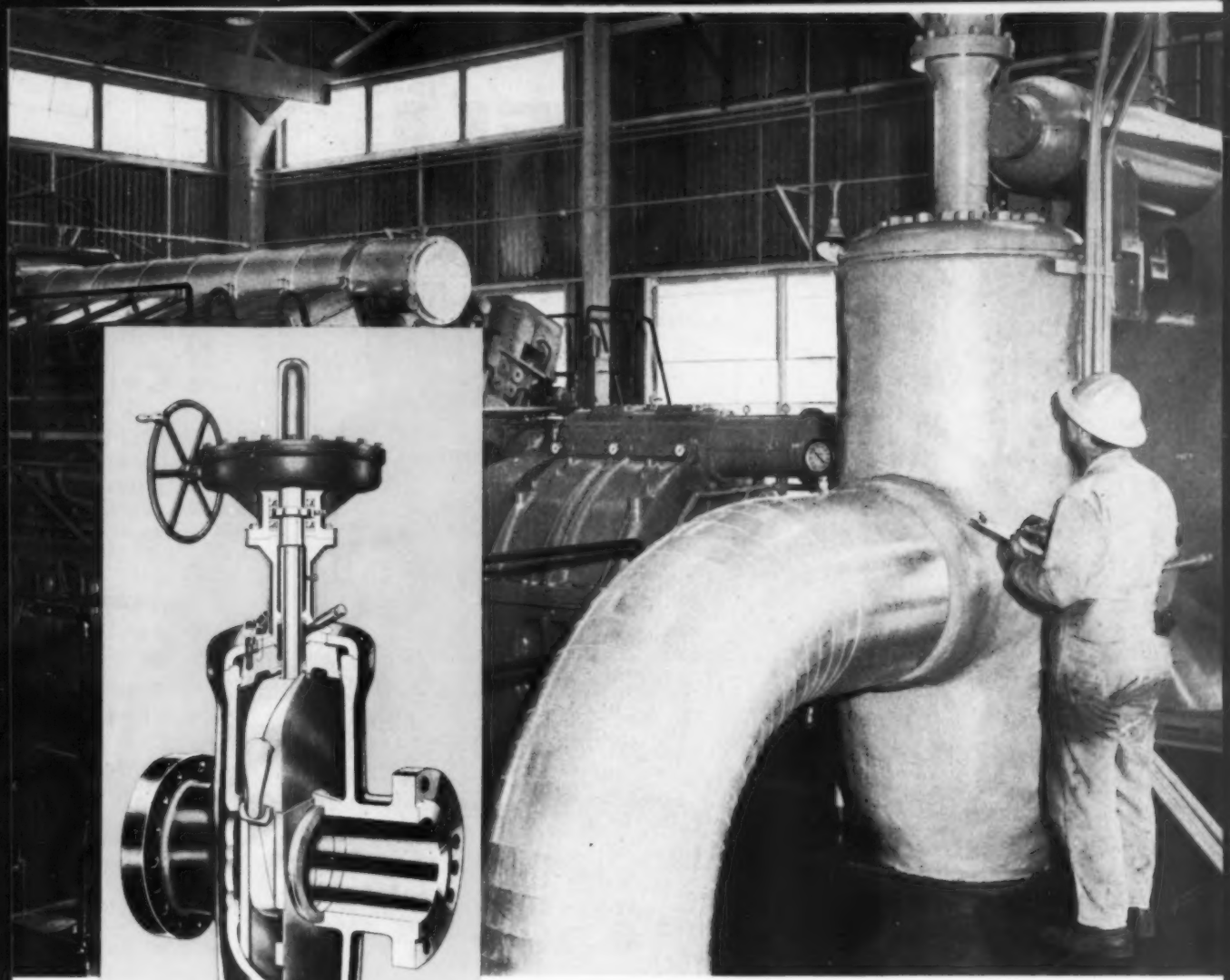
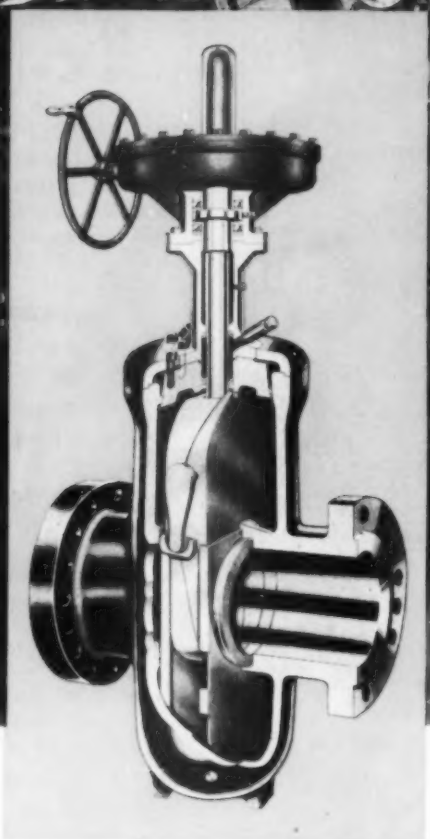


TENSILE STRENGTH of a bolt is tested in Caterpillar Laboratories. Each bolt is capable of supporting the full weight of the tractor for which it is designed.

DON KOPP, Master Mechanic, McCann & Co., Inc., Springfield, Ill.: "We're real boosters of genuine Cat parts, especially track parts. Other brands just don't last as long. When you buy Cat parts you know they are going to fit, last longer and give the best service because they are built to do the job by the people who built the machines."





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sets the standards for pipeline valves around the world

From 2-inch to 34-inch, W-K-M's ASA gate valves have earned the commendation of pipeliners from California to Iran, from Peru to Canada.

And why not?

No other pipeline valves are so carefully engineered to meet the practical requirements of pipeline service. No other valves will give you the same performance, the same long life, the same long-range economy. No other valves can be so easily or quickly overhauled "on-the-line."

For complete dependability, specify W-K-M when you requisition valves.

The W-K-M® ASA Gate Valve can be overhauled "on-the-line"

W-K-M designed this valve to save you time and money. W-K-M valves give you longer service between overhauls, and when overhaul is necessary, you can do the job while the valve is *on-the-line*. This one feature saves users of W-K-M valves thousands of dollars each year.

Other features include: Full bore through-conduit; exclusive gate centralizing mechanism; freedom from destructive turbulence; no-surge operation; free passage for pigs or scrapers.

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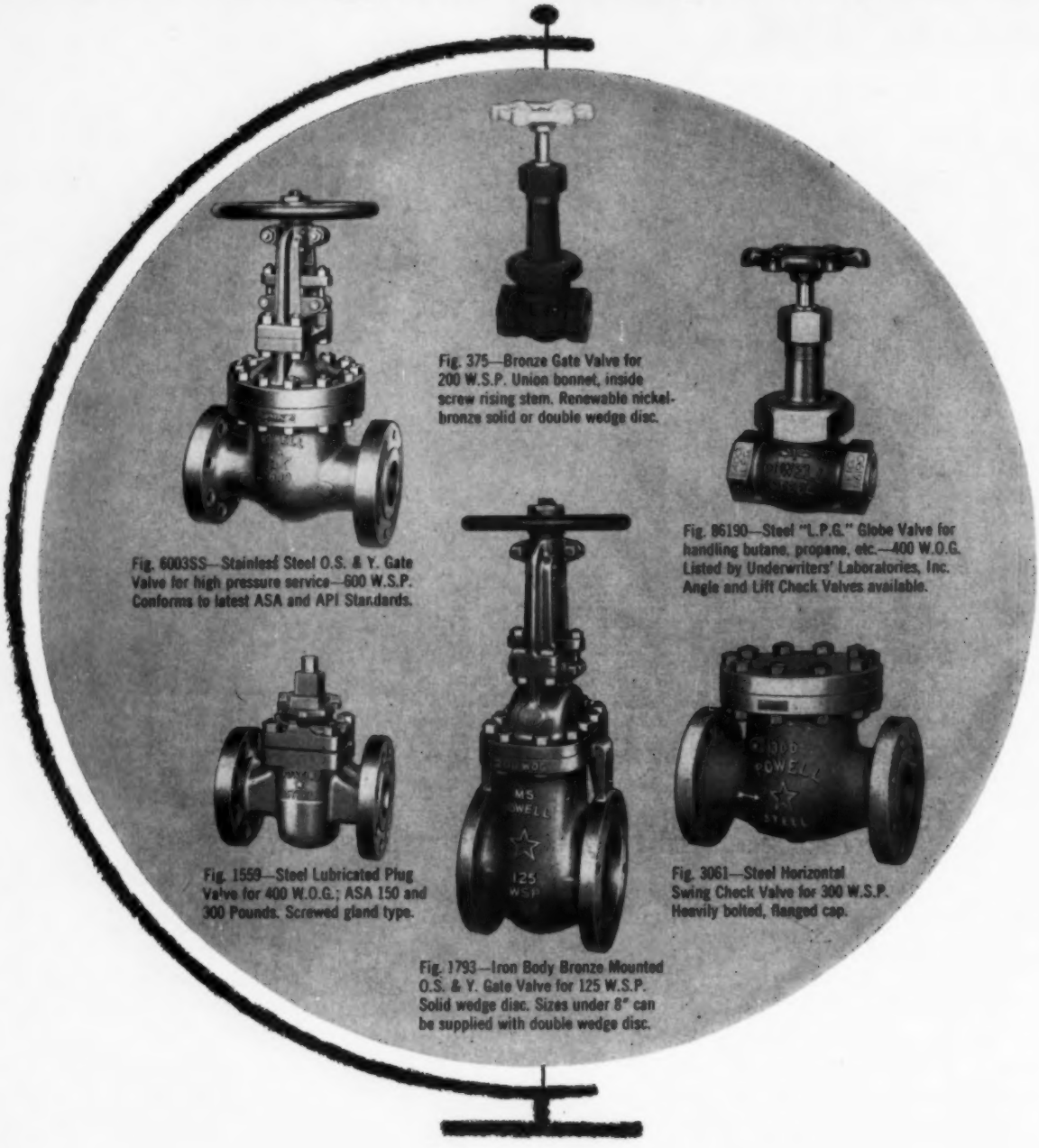

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

Fig. 6003SS—Stainless Steel O.S. & Y. Gate Valve for high pressure service—600 W.S.P. Conforms to latest ASA and API Standards.

Fig. 86190—Steel "L.P.G." Globe Valve for handling butane, propane, etc.—400 W.O.G. Listed by Underwriters' Laboratories, Inc. Angle and Lift Check Valves available.

Fig. 1559—Steel Lubricated Plug Valve for 400 W.O.G.; ASA 150 and 300 Pounds. Screwed gland type.

Fig. 1793—Iron Body Bronze Mounted O.S. & Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

Fig. 3061—Steel Horizontal Swing Check Valve for 300 W.S.P. Heavily bolted, flanged cap.

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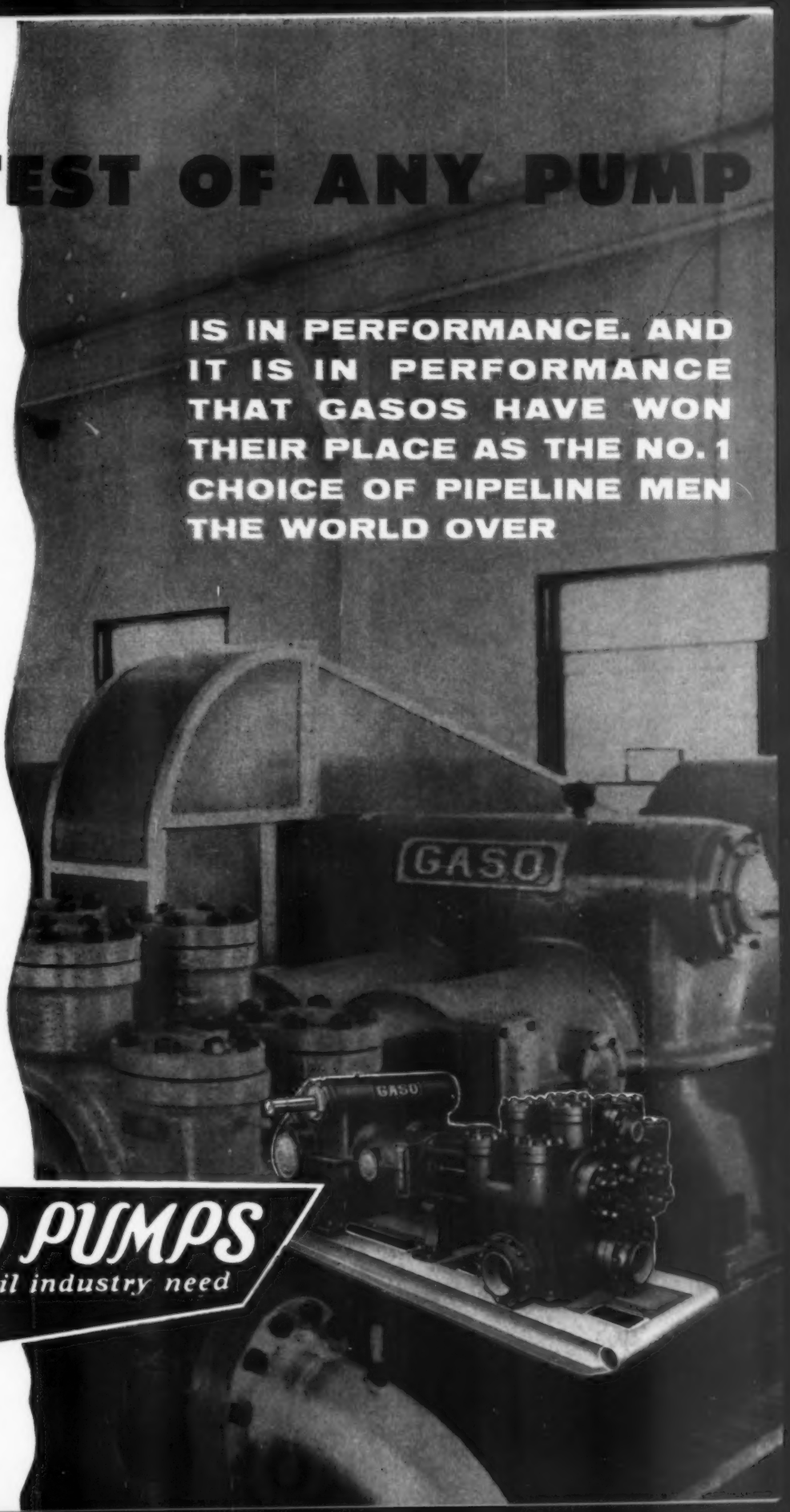

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Some 3 million yards of blasted rock, conglomerate, and dirt are moved in construction of a 256-mile natural gas line in Arizona. The going is rough — up and down steep grades. Three Bucyrus-Eries, including the one shown here, were used on the spread.

Optional tractor type crawlers, available for the ½-yd. 15-B and the ¾-yd. 22-B, provide extra clearance for travel over rocks, stumps, and most other obstructions you might run into. You keep trenching. There's little time lost to clear the way. Shoes have deep grousers for sure traction in soft ground and for climbing steep grades. No need to hitch on to another machine for help up hills or through muck. You keep *all* your machines busy making money.

Look over the jobs pictured. See how Bucyrus-Eries with tractor type crawlers trench through hilly country, in water and muck, amid rugged forest terrain. Then see your nearby Bucyrus-Erie distributor for a complete rundown on these machines. You'll find out why these money makers have become the trenching favorites with pipeline contractors all over the country. 529E58

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A Familiar Sign at Scenes of Progress

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Working 10 hours daily, 7 days a week, this 22-B demonstrated its ability to stay on the job come mud or high water — even a trench full of water as shown. It was one of two Bucyrus-Erie hoes used to trench for a natural gas pipeline across northern Pennsylvania.

When all the hoes on your spread are Bucyrus-Erie you get top performance all the way through. That's why many pipeline contractors are switching completely to Bucyrus-Eries. Here are two of the three Bucyrus-Eries that were used to trench for a natural gas line running across Pennsylvania, New Jersey, New York State, and into New England. They are shown working in a rough, heavily wooded area near Milford, Pa.

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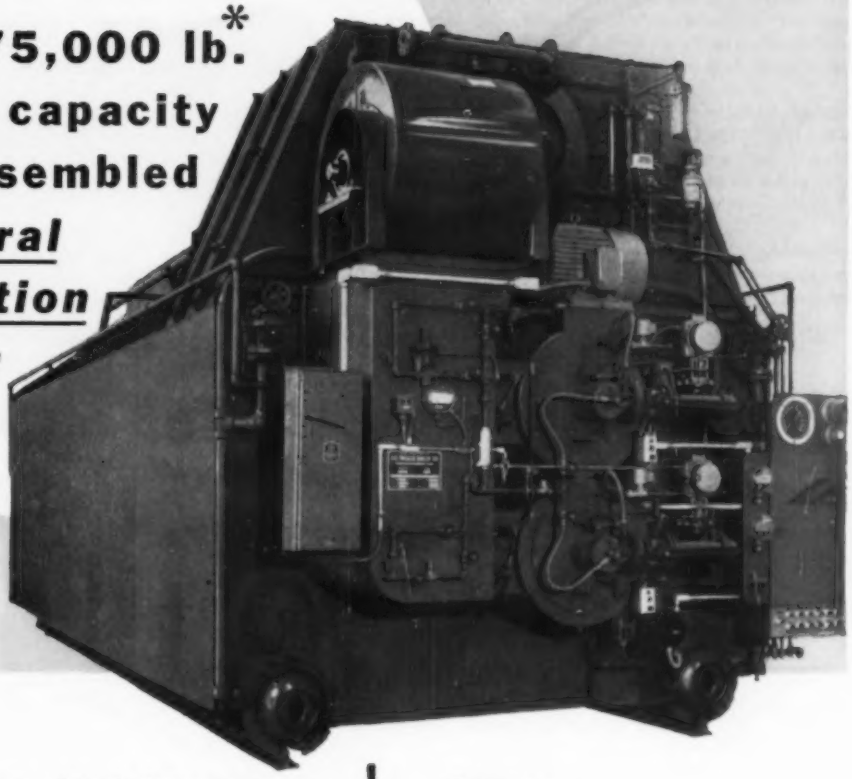

*75,000 lbs. per hour present capacity.
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Silent Weapons

No one should miss the article "Silent Weapon of the Cold War" in the *Saturday Evening Post* of October 18, 1958. Demaree Bess tells exactly how the Communists have used runway inflation in their successful conquest of much of the world. Soviet economists, Mr. Bess points out, are orthodox and conservative. They have stubbornly clung to such old fashioned notions as balanced budgets and sound money, but their use of inflation to pursue economic warfare has been highly successful. The author names the significance to us; "Financial irresponsibility in the United States would suit Moscow best... if inflation gets out of control they can forget about such weapons as inter-continental missiles."

★ *I often think no man is worth his salt until he has lost and won battles for a principle.* —John Marsh

$22 Billion Wasted

The nation is paying shocking ransom to the underworld amounting to $128 a year for every man, woman, and child, declared FBI Chief J. Edgar Hoover at the American Bar Association's annual convention. He said the estimated annual cost of crime now totals a staggering $22 billion a year. "The moral fiber of the nation is growing weaker, not stronger, at this most crucial period in world history" he declared. "We have tried the practice of overindulgence, and it has failed. In the interest of self-preservation it now is time for sterner measures."

Company History Published

A report on General American Oil Company of Texas has been made by Blyth and Company, Inc. The growth of the company since its incorporation in 1936 makes highly interesting reading. Algur Meadows, the founder, pioneered the production payment technique of petroleum financing. In this way General American has acquired in the last 20 years more than $140 million of producing properties with a cash outlay of less than $25 million, and negligible funded debt. Operations have been consistently profitable since its incorporation in 1936.

Sound management, as the report emphasizes, has been the key to General American's success. Eight of the 20 present officers helped build the company. Meadows is now chairman of the board at age 59 and plans to remain active in guiding its future growth. The president is Judge Gordon Simpson, who is also president of Independent Petroleum Association of America.

The report is available at any of the 24 Blyth offices in the United States.

Ideas in Action

Esso Research and Engineering Company has published a fascinating booklet on its operations.

"Ideas in Action" is introduced with this statement:

"At Esso Research and Engineering
"Ideas are the raw materials
"Science, the tool
"Scientists, the workmen
"Progress, their product"

The booklet tells us there are more than 1000 research projects underway at any one time. More than 3000 men and women work in the research centers and another 500 people are employed in affiliated labs. In addition these groups work closely with others of affiliated companies here and abroad. Copies of the booklet can be obtained by writing Esso Research and Engineering Company, P. O. Box 45, Linden, New Jersey.

Vision Ahead?

Trachoma is widespread in the Middle East, the Far East, and parts of South America, Africa, and Asia, and throughout central and eastern Europe. In some Middle East areas up to 100 percent have or have had it. It is one of the oldest known diseases, reference being found in Egyptian manuscript of 1500 B. C.

Trachoma does not kill, but it frequently impairs vision if not promptly treated, and thousands of victims eventually become blind in one or both eyes. There is no positive cure for it although the sulfur group and certain antibiotics seem to be partially effective.

Now work in the laboratories of the Arabian American Oil Company in Saudi Arabia has brought to light a virus which is toxic to small laboratory animals. The discovery opens the possibility of testing efficiently the viruses present in trachoma to determine if they are closely related or are different in their properties.

The discovery was reported at the Sixth International Congress on Tropical Medicine by three Harvard doctors. The trachoma research program is being conducted jointly by Aramco and Harvard University.

Writing Is Important

In the August issue of *The Petroleum Engineer* an article on "Authorship and Company Policy" outlined the plan of one company in regard to its scientific and technical personnel writing for publication. Recently through the Technical Writing Improvement Society we have learned of Convair's procedure along this line.

Convair has a Writing Award Fund to encourage production of articles for trade and technical journals by its personnel through a system of monetary rewards for authors of accepted manuscripts. In this case, of course, the subject matter is restricted to material of specific interest to the aviation industry.

A special assistance in public relations is available to help in preparation of illustrations. The articles are checked by the author's supervisor and by the engineering and security department. The division manager then channels the articles through the manager of public information for submission to magazine editors. The article is sent first to the magazine preferred by the author.

Payment of $150 for each article is made to the author at the time of acceptance of the article. Company personnel are not permitted to accept fees from magazines in addition to the fees paid from the Writing Award Fund. In other companies the author is allowed to accept payment from the magazine in addition to payment made by the company.

60,000 Executives to School

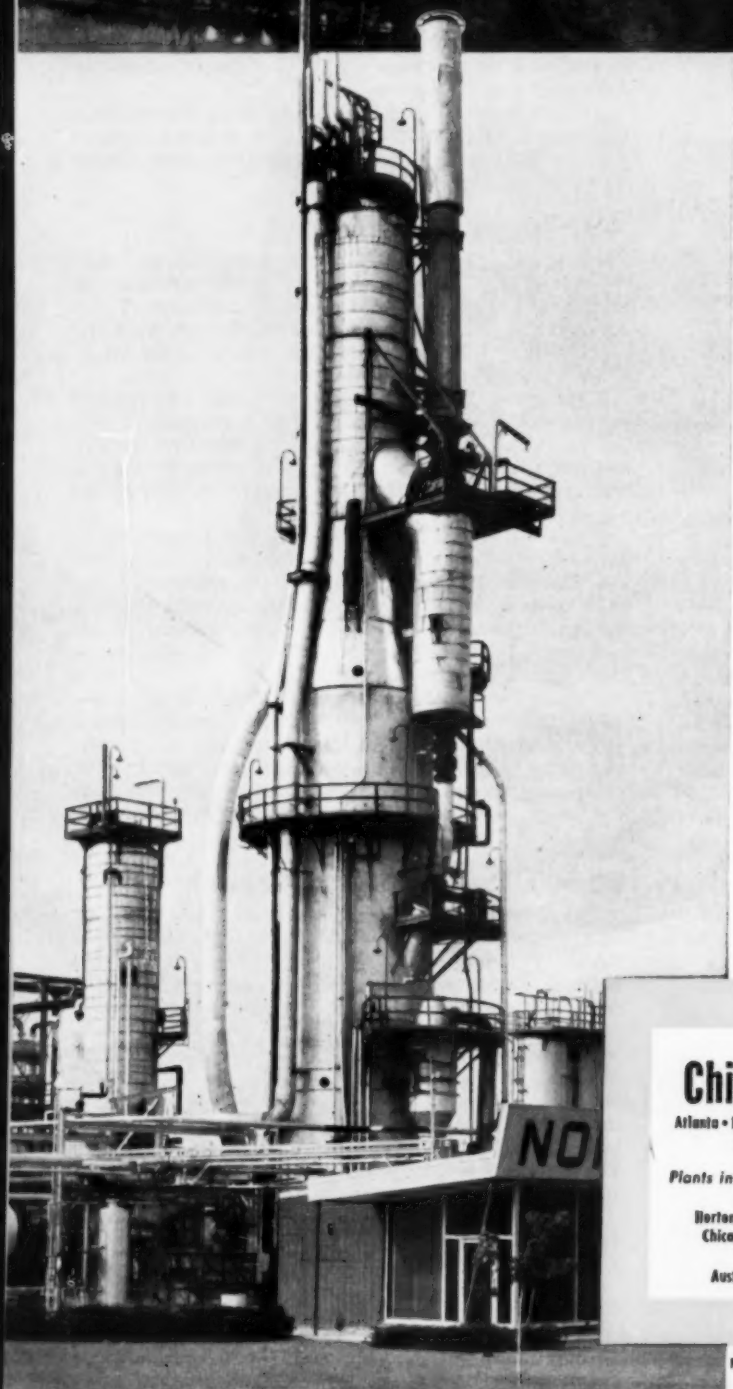
One of the startling trends of our time is the post graduate education of management. Under one organization, American Management Association, more than 60,000 business executives are expected to attend more than 1000 educational meetings to be conducted from last fall through next June.

AMA's oldest continuing course is a four-week management course. Another new course called the "Competitive Business Simulation" course is held for one week. Also there is the "Executive Action" course, a three-week's study in how to get things done through people; a "Supervisory Development" course, three weeks of management training for first-line supervisors, and many others.

This does not begin to tell the story of how many go back to school, as nearly every large university and most companies conduct supervisory and management courses.

20 CB&I STRUCTURES

serve refinery expansion at Twin Cities



CB&I tanks and towers keep pace with NORTHWESTERN growth

Over the past 10 years CB&I has built storage tanks for nearly 900,000 barrels of crude oil and petroleum products for the fast-growing Northwestern Refining Co. of St. Paul Park, Minnesota. CB&I also built the reactor-regenerator for the refinery's modern UOP cracking unit, shown at left.

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This is why so many CB&I customers are *repeat* customers. Write our nearest office for the bulletin: *CB&I Special Plate Structures.*

Top: CB&I-built storage tanks at Northwestern include 80,000 bbl. Horton® Floating Roof crude oil tanks and jet fuel storage tanks.

Left: UOP Cat Cracker at Northwestern includes CB&I-built 10-ft. diam. reactor, 16½-ft. diam. regenerator.

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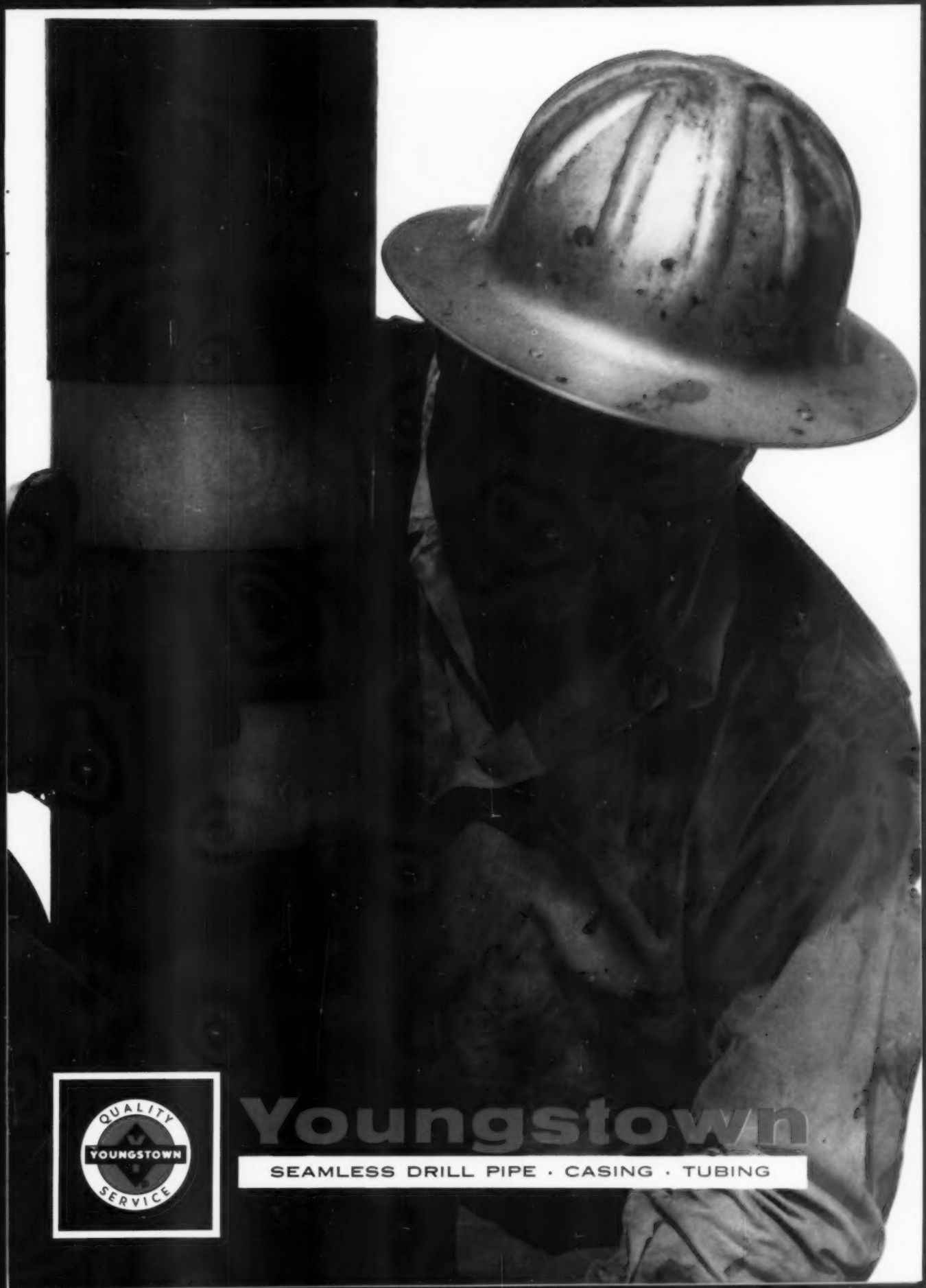
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United States Petroleum Forecast

and Dynamic World Growth in Demands

Are we across the demand plateau, ready to resume a rise in consumption? . . . Here is a prediction of 4% or better increase for U. S. in 1959 — and of 11% for the Free Foreign area

Austin Cadle

ABOUT MID-1957, United States petroleum demand consummated several years of expanding growth to arrive at a plateau from which it is now resuming its climb toward higher elevations.

The year 1959 should witness an increase in domestic demands of 4 percent or better. I would expect gasolines to approximate such a demand increase and jet fuels to increase by some 11 percent. Even distillates and residual fuel oil should gain somewhat, despite competition from natural gas. Thus demands should be getting back on the trend to continually higher elevations as succeeding years unfold.

In the total Free Foreign area, demands next year should increase by approximately 11 percent.

Population Growth

Fundamentally, markets for petroleum products are made by people. Forecasts indicate that the Free World's population will exceed 2 billion by 1975, an increase of about 30 percent over today's level of 1.6 billion.

Fig. 1 illustrates that regional rates will differ significantly. United States population is expected to grow by 33 percent in the next 18 years to 227 million people.

Fastest regional growth is anticipated in the Western Hemisphere outside of the United States, where 1975 population is forecast at 291 million, or 50 percent over today's level.

Western Europe's population is likely to show the slowest rate of growth, increasing only 12 percent, to 352 million persons. One reason for this relatively slow rate of growth is the anticipation of continued high emigration.

Greatest population growth in the Free World is expected to occur in the balance of the Eastern Hemisphere, where 1975 population will total over 1.2 billion, or 31 percent greater than today's level.

Energy Requirements

Rates of growth in population become meaningful only when related to the state of economic development peculiar to an area. Of several yardsticks used by economists, a measure of total energy requirements is particularly useful. The energy market available to oil will remain a major determinant of future petroleum demands.

Energy requirements have increased consistently in the past, except during periods of world war and depression, at an average rate exceeding 4 percent per year. This rate reflects not only demands created by expanding population, but also those occasioned by increased productivity.

One half the world's energy requirements arises in the United States, and some 46 percent are met by petroleum. Despite the extent to which our country has outdistanced the world in the use of energy, it will continue along an expansionary trend.

By 1975, total Free World energy requirements will practically double, reaching the staggering figure of 75,000,000 bbl daily in oil equivalent. Of this total some 50 percent will be met by petroleum, a figure which indicates both an absolute and a relative overall gain for petroleum marketers.

Fig. 2 shows regional differences are again significant. In the United States, 35,000,000 bbl daily (oil equivalent) should be reached by 1975 — an 83 percent increase. Lesser absolute increases, but at faster rates, will occur in the Western Hemisphere outside the United States, at 161 percent, and in the Eastern Hemisphere excluding Western Europe,

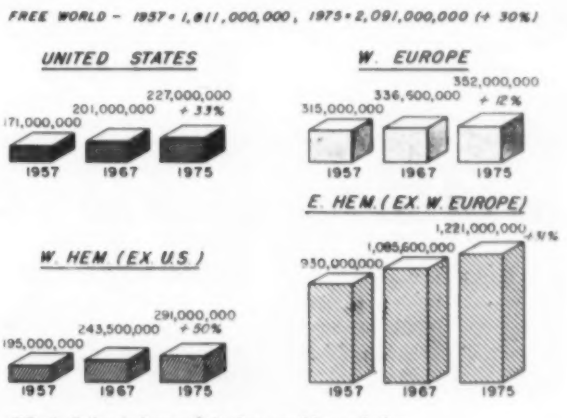

FIG. 1. Estimated growth in free world population.

EDITOR'S NOTE: This article is a condensed version of a paper presented to the 38th annual meeting of the American Petroleum Institute, Chicago, November 11, 1958.

The Author

Austin Cadle, *after receiving a degree from Stanford University in 1921, joined Standard Oil Company of California. He has been draftsman in the general engineering department; analyst and geologist, department of economics; head, economic cost analysis division, comptroller's department; and since 1946, manager of the economics department. Cadle is a member of the API, AIME, Western Oil and Gas Association, National Petroleum Council, and is a consultant for the office of oil and gas, U. S. Department of the Interior.*

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where energy demands will rise 142 percent. In Western Europe requirements should be about 73 percent over today's level.

Growth in Petroleum Demands

From region to region we expect total petroleum demands to change as follows:

	1957-1975		
	Change in petroleum as percent of energy requirements	Increase in million b/d	Increase in percent
United States	−2	6.7	76
Western Europe	+22	6.3	229
W. Hemisphere (Ex. U.S.)	+4	4.0	174
E. Hemisphere (Ex. W. Europe)	+14	4.3	214
Free World	+9	21.3	134

Fig. 3 illustrates rates of growth anticipated for principal petroleum products from 1957 to 1975. Reasons underlying these rates of growth differ from region to region, and it is worthwhile to examine factors affecting demands in each of the four major regions, by major products.

U. S. Petroleum Demand

Gasoline. In the future, total gasoline demand is anticipated to grow under the continuing impact of growing population, multi-car families, shorter working hours and longer vacations. Declining uses of aviation gasoline will be more than offset by jet fuel for rapidly expanding air travel. By 1975, motor gasoline (of whatever type it may be) and jet fuel demand will exceed 50 percent of total domestic consumption of petroleum products and be roughly double 1957 levels.

Distillates. Chief growth factors underlying distillate demands are associated with mobile and stationary power uses. Expanded construction and road-building activity will increase diesel demands at a rate of growth paralleling motor gasoline. The railroads will be completely dieselized. However, these gains will be partially offset by slower rates of growth in heating oil markets (owing to increased availability of natural gas) and by expanding use of residual fuel oil in diesel engines. By 1975, distillates will total only about 16 percent of total domestic sales, but this will represent a 47 percent increase over 1957 volumes.

Fuel Oil. Of all major products, fuel oil will probably suffer the greatest competition from alternative sources of energy. Increasing availability of natural gas will result in gradual displacement of residual fuel in industrial and electric plants in the Western States, but will be offset by expanding Northeastern markets. A further offsetting factor may be the trend toward burning heavy fuel in rail and marine diesel engines. In 1957, United States fuel oil demand totalled 1,500,000 bbl a day, 17 percent of the total. By 1975, this demand is forecast to increase to 2,200,000 bbl a day, constituting only 14 percent of a total product barrel.

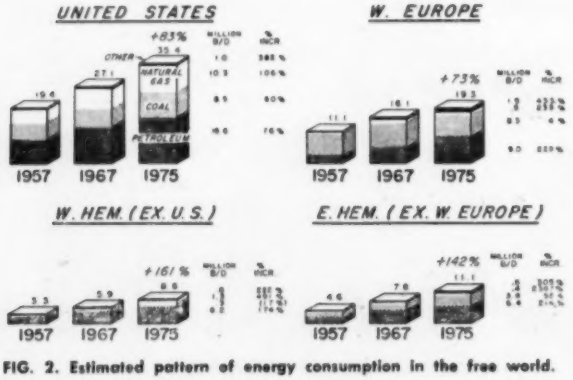


FIG. 2. Estimated pattern of energy consumption in the free world.

Demand in Other Areas

Overall product demands in foreign areas are increasing at treble the rate in the United States, with the greatest increase occurring in Western Europe.

Gasoline

Western Hemisphere (Ex. U. S.). In Canada and Latin America air travel has grown rapidly. Airlines have expanded passenger services at the expense of sea and rail transport. As the 1960's usher in the "Jet Age," jet demands will spiral, more than offsetting decreasing rates of increase for aviation gasolines.

Motor gasoline demand in this area should grow rapidly as incomes increase and become more evenly distributed. Both Canada and Latin America are many years away from saturation in vehicle ownership per unit of population and well below United States levels. We may expect continued growth in vehicle registrations. For these reasons gasoline demands will treble by 1975.

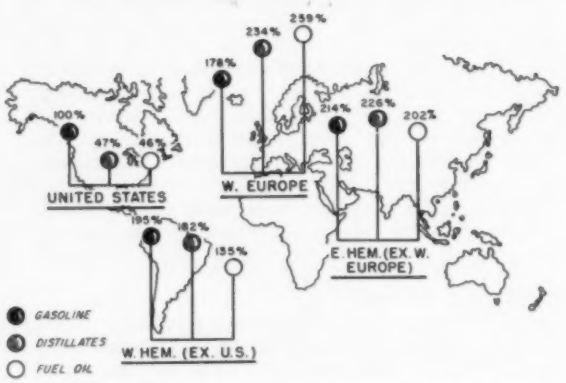


FIG. 3. Estimated growth in world petroleum major product demands, 1957-1975.

Western Europe. In Europe, ratios of vehicle ownership are modest when measured by United States standards. Increasing industrialization, development of the common market, a trend toward increased standards of living and government highway programs all indicate a promising future for motor gasoline demand. Total gasoline demand by 1975 will be triple 1957, reaching 2,000,000 bbl a day.

Eastern Hemisphere (Ex. W. Europe). Asia and Africa are vast in terms of area, population, and latent large-scale economic development of natural resources. By Western standards, many of these countries endure extremely depressed living conditions. Even modest increases in income levels could materially add to vehicle registrations. Air travel, too, will increase demand and continue to outgrow

rail and sea transportation. Total gasoline demand will more than treble by 1975.

Distillates

Western Hemisphere (Ex. U.S.). In countries such as Canada, Mexico and Argentina, natural gas will invade industrial fuel and home heating markets. Thus increases in demands for heating oils will be limited to areas where a competitive advantage over solid fuels continues. The strongest advances in distillate demand will occur in highway, agricultural and construction diesel engine use. By 1975, gas oil demand in this region will triple and roughly make up 20 percent of all product demand.

Western Europe. Europe is on the threshold of large-scale distillate demand. Low-cost natural gas is not available to the extent that it is in North America. Coal has become less available locally at competitive prices. Even imports of United States coal appear to be an unlikely long-range competitor, owing to rising costs. Distillate demand will more than treble by 1975.

Eastern Hemisphere (Ex. W. Europe). In several countries of Asia and Africa, a sizable conversion to heating oils from solid fuels should occur as the latter become more costly. Natural gas is not expected to be available through most of the area. Demands for distillates, including kerosine, will treble by 1975, reaching 1,200,000 bbl a day.

Fuel Oil

Western Hemisphere (Ex. U.S.). Fuel oil use in industrial plants, in electric utilities and steam vessels and in heavy duty diesel engines is expected to grow about two and a half times the 1957 levels by the mid-70's.

Western Europe. Fuel oil demand in Western Europe will nearly quadruple to 1975. Fuel oil's primary function will be to fill the gap between energy requirements and domestic fuel supplies. In addition, petroleum will increasingly replace coal as the primary source for industrial fuel and electricity generation. Thus on balance, 1975 residual fuel oil demand should exceed 3.8 million barrels a day, some 42 percent of total product demand.

Eastern Hemisphere (Ex. W. Europe). In Asia and Africa, 1957 fuel oil demand totaled less than 900,000 bbl a day. By 1975, demand will reach 2,600,000 bbl a day.

Nuclear Energy

Discussion of long-term future demands would not be complete unless we touch upon the outlook for peaceful uses of nuclear energy. Production of electricity is the furthest advanced, but it is still far from being economically competitive with liquid fuels or coal. A number of plants are under construction and more are planned both in Europe and the United States, but the combined capacity of all plants scheduled by the mid-sixties is considerably less than the capacity added to the United States total power system in the course of a single year. On the basis of current cost predictions, it is difficult to visualize any extensive development of nuclear power plants for another 10 or 15 years. Even if all such installations in the long-term future were to be nuclear, it would replace a very small percentage of the total consumption of liquid fuels.

There are good possibilities for nuclear propulsion of merchant ships, which currently absorb 1,500,000 bbl per day of oil. However, the effects upon total petroleum demand will not be pronounced.

Refining Facilities Needed

Directly associated with these are requirements for new refining, transportation and marketing facilities.

Fig. 4 defines the approximate requirements for refineries to satisfy the demands that have been estimated. In support of these refineries, it may be said that the world contains

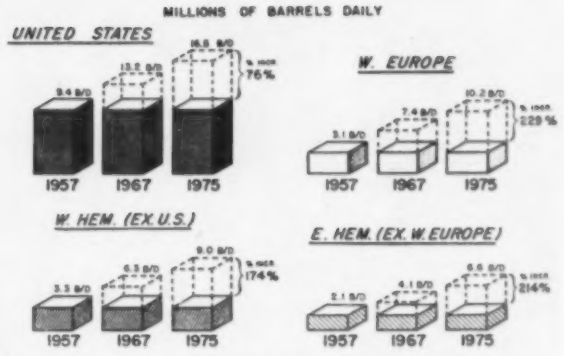


FIG. 4. Estimated additions to refining capacity needed by 1975.

ample proved and potential reserves of crude oil, and I would estimate that some 6500 T-2 equivalent tankers would be required for transportation, vs 2300 in 1957.

In 1957, Free World crude refining capacity totaled 18,000,000 bbl per day. Of this, 52 percent was in the United States, 19 percent in other Western Hemisphere, 17 percent in Western Europe, with the remaining 12 percent in other Eastern Hemisphere.

Predicated upon the demand patterns as outlined, 1975 Free World refining requirements will increase by about 136 percent to around 42,000,000 bbl per day. On a rule of thumb basis this would mean new fixed investment charges of about $20 billion in the next 18 years, or a little over $1 billion per annum. Add to this a need to provide terminal storage facilities, marketing outlets as well as crude and product transportation media, and you could readily come to an investment figure staggering to the imagination.

In addition to new problems surrounding quality requirements of the future, the refining branch of the industry will be faced with a need to shift yield patterns to meet product demands. In the United States, Canada, and Latin America, demand patterns show a growing emphasis on light products and declining fuel oil.

In Europe, the emphasis will be heaviest on the black oils with probably some down-grading of current yield patterns. The pattern of yields required in the balance of the Eastern Hemisphere shows very little change. Refining in this area may swing more in the direction of topping operations, coupled with catalytic reforming to achieve a necessary balance of yield patterns and gasoline quality.

Conclusions

Major features of petroleum's future are:

1. *Demands have by no means reached a saturation point in the United States petroleum industry.*
2. *Future pattern in the underdeveloped areas of the Western and Eastern Hemispheres is one of rather astounding future expansion in the use of petroleum.*
3. *Western Europe shows even greater potentialities; and in that area, as well as the balance of the Eastern Hemisphere, prospects for distillates and residual fuel oil exceed the percentage increases expected for gasoline.*
4. *These increases in demand translate into a growing need for huge development of crude oil production and for the building of transportation, refining and marketing facilities.*

Finally, I am convinced that the future holds many opportunities for the petroleum industry. Increase in demands for its products will be truly dynamic. There is nothing on the horizon that can destroy its continuance as an outstanding growth industry, in foreign areas as well as in our own country. ★ ★ ★

If you look deeply into this valley in the Andes you can spot the Los Manos Camp on the Chaco lease.

Interest Quickens in Bolivian Oil Potential

Some 20 companies are seeking reserves in the Beni and the Chaco regions — the industry is growing in this land-locked heart of South America

R. S. Randerson, Jr.

WHEN you talk about Bolivian oil operations you have a feeling that the curtain is rising on an exciting show that will have a long run.

Although only two operators are drilling at the present time, Bolivian Gulf Oil Company and Chaco Petroleum, S. A., which operates the Chaco lease for Tennessee Gas Transmission, Union of Louisiana, Lion Oil, and Murphy Corporation, there has been a brisk business in concessions awarded private capital. (See Table 1.)

This activity dates from January 24, 1956 when a new petroleum code went into effect. For the first time since Jersey's Bolivian subsidiary was expropriated in 1937, foreign private capital was invited to come into Bolivia to explore and develop its oil resources.

In addition to more attractive laws, Bolivia is one of the countries in which it is possible to insure U. S. investment.[1] It is insured by the Federal Government against: (1) Inability to convert foreign currency receipts into dollars and (2) expropriation or confiscation of properties.

[1]This insurance is carried by the United States Government to encourage private American investment abroad and the fee for each type of coverage is ½ to 1 percent of the total dollar amount of protection. It does not protect against general devaluation of a foreign currency, nor against physical damage to property from war or any other cause, but it does make it more attractive for risk capital to be put into ventures of this type.

Early Operations

Earliest operations in Bolivia began after World War I, when concern over possible oil shortage spurred a worldwide search. Standard Oil Company of Bolivia (Jersey) acquired a concession in the heart of the tropical jungle remote from all transportation facilities.

Between 1921 and 1937 Standard of Bolivia surveyed 18,000 square miles within the concession and spent $17,000,000 exploring and drilling 28 wells.

and constructing camps, roads, sanitation facilities and two small refineries. It maintained over 600 miles of roadway between Yacuiba and Santa Cruz in order to move in drilling and camping equipment.

In December 1936 the Yacimientos Petroliferos Fiscales Bolivianos, a government-sponsored oil enterprise, was created. Three months later the government declared forfeit all of Standard's possessions in Bolivia, including the wells, refineries, equipment, records, and office furniture, and transferred them to the YPFB.

From that date until 1952, the YPFB was the entire petroleum industry in Bolivia. The government's settlement with Jersey Standard was payment of $1,500,000 to the company for all its interests, rights, and properties in Bolivia.

Not much developed from then until 1952 when YPFB awarded a lease on approximately 900,000 acres in the southern part of Bolivia near Yacuiba to Glenn McCarthy of Houston. McCarthy drilled three wells on the Los Monos structure, none of which are considered to be commercial, and in 1957 sold his interest in the Chaco lease to the four-company group headed by Tennessee Gas for $1,500,000 cash and $1,500,000 oil payment.

TABLE 1. Bolivian Concessions.

Company	Zone	Acres
Bolivian Gulf Oil	I	1,235,500
	II	2,718,100
		3,953,600
Compania Petrolera Bolviana Shell	I	1,232,000
	II	3,700,000
	III	3,000,000
		7,932,000
White Eagle International	I	1,235,500
	II	988,400
		2,223,900
Andes Oil (Pure Oil, Sohio, Hancock)	I	1,235,310
Bolivian Petroleum (Drilexco—as consultants)	I	1,235,500
*Chaco Petroleum, S. A. (Operating Chaco lease for Tenn. Gas, Union of Louisiana, Lion Oil, Murphy)	YPFB	900,000
Bolivian American Oil (U. S. Corp.)	I	361,831
Fish Engineering	YPFB	98,840
TOTAL ACRES		17,940,981
CONCESSIONS PENDING		
Cataract Mining Corp.	I	283,547
Bolivia California Pet. (California exploration)	I	1,235,105
	II	3,705,143
		4,940,249
Bolivian American Oil	I	473,891
	II	388,757
		862,648
Bolivian Gulf Oil	I	988,400
TOTAL ACRES		7,074,844

*Originally granted to Glenn McCarthy.

These men worked out the TULM contract with the Bolivian oil entity: (l. to r.) Stuart P. King, director of overseas operations, Tennessee Gas Transmission Company; Wilton E. Scott, vice president, TGT; Sam C. Oliphant, vice president, TGT; Earle F. Taylor, president TULM Corporation; Eduardo Hinojosa, former general manager, YPFB in La Paz; Jose Paz Estenssoro, president of YPFB.

Geology and Terrain

It might be a good idea to get a quick glance at what the oil crews see. Bolivia has three distinct areas: (1) The mountain area, which lies along the west and varies from an elevation of 5000 ft to over 23,000 ft at Mt. Illampu, (2) the Amazon jungle country of the Beni, and (3) the Chaco region of the southeastern portion of the country.

The mountain area is a relatively arid country with few trees, devoted mainly to the raising of grains during the rainy season.

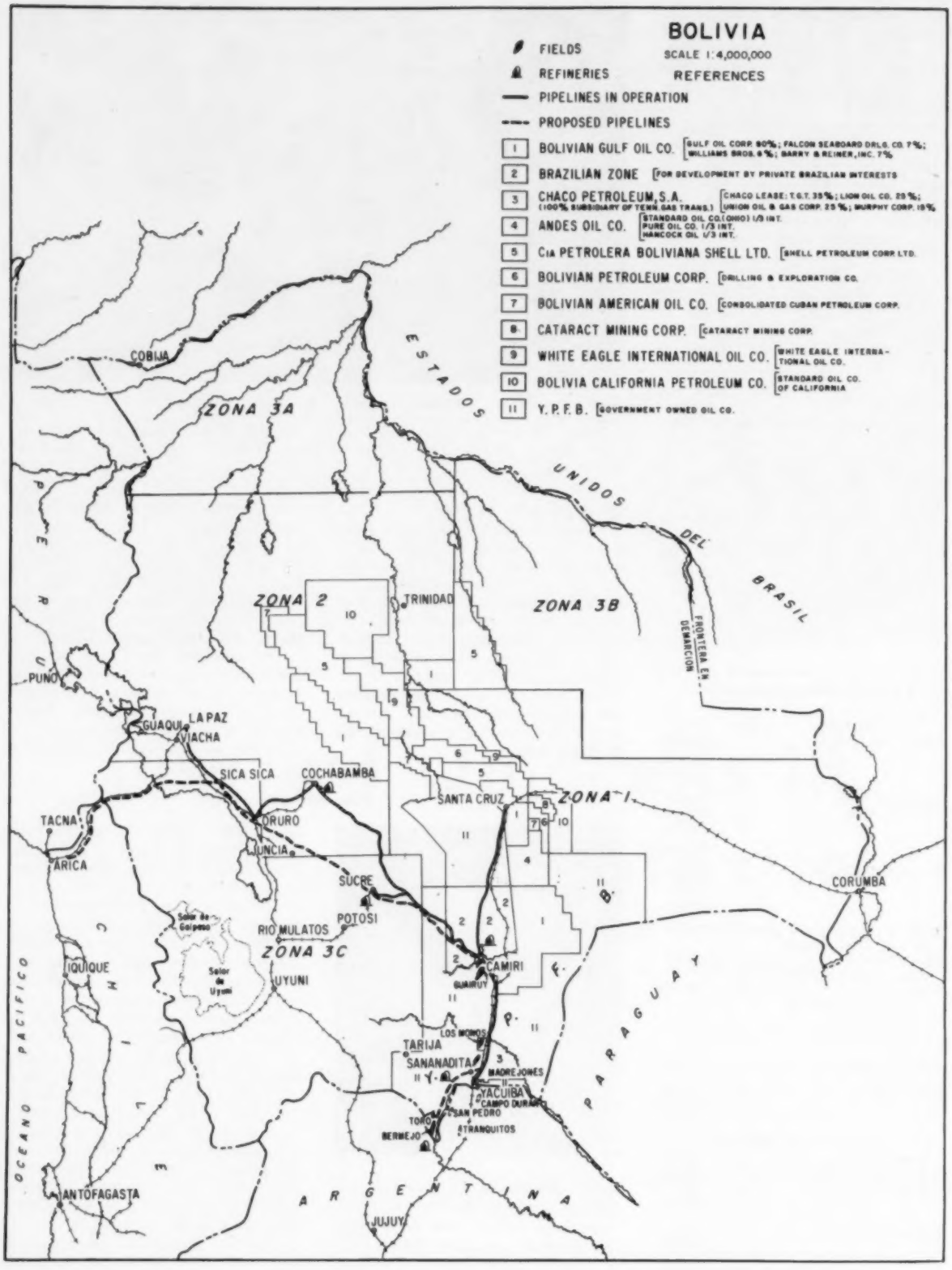
It contains a number of very high lakes, among them Lake Titicaca, at an elevation of 12,500 ft which is the highest navigable lake in the world. This is the region of the famous tin mines and of the richest silver mine the world has ever known—one that attracted the Spanish conquistadores.

The Beni and the Chaco are the regions being explored for oil. The Beni forms a part of the headwaters of the Amazon River and the dense jungle country is famous for its swamps, its anaconda snakes, and its enormous

The Author

Roy S. Randerson, Jr., *serves as production coordinator for the production, exploration and overseas departments of Tennessee Gas Transmission Company in Houston, Texas. Graduated from Kemper Military School, with an associate engineering degree and from the University of Oklahoma with a BS in business administration, he later graduated from the Naval Supply Corps School conducted by the Graduate School of Business Administration of Harvard University. In 1941 he was employed by Pure Oil Company in Houston, Texas, and worked there and in Dickinson, Texas, until he entered the Navy in 1943. He served as disbursing officer aboard the aircraft carrier Bataan during major battles of the Pacific. He emerged from the Navy in 1946 as a Lieutenant Commander and was employed in the production department of Pure Oil in Chicago until 1949 when he went with the producing subsidiary of Tennessee Gas Transmission. Since that time he has served in various capacities, the latest, prior to his current assignment as production coordinator, being assistant division production manager of the Gulf Coast Division in Bellaire, Texas.*

This past year he has spent time in South America in connection with Tennessee Gas' expanding overseas operations and in setting up the company's fully owned subsidiary, Chaco Petroleum, S.A.

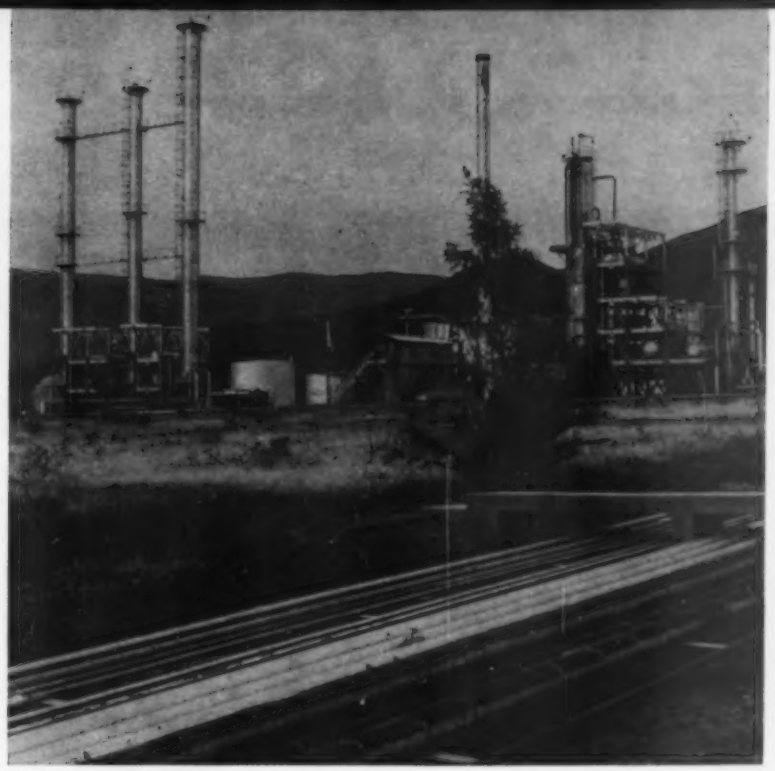


BOLIVIA: Its oil operations

jaguars. The country is still inhabited by wild Indians and has very few settlements.

The Chaco area is a relatively flat, relatively dry forest country. It has a climate similar to Dallas, Texas; is subject to cold south winds in the winter season similar to "blue northers." The Chaco country is unique in that only two rivers, the Rio Grande and the Rio Pilcomayo, reach the sea. Other rivers may flow torrents when they leave the Andes Mountains but when they reach the dry Chaco they are lost, piling up enormous sand dunes where the river disappears.

Wherever there are sedimentary basins with thick marine deposits, an excellent chance exists for major reserves of oil and gas. These conditions exist in Bolivia; and because of the current existence of production, it can be safely assumed that source beds are also present. While exploratory drilling to date has not been too encouraging, the well density is so small that no conclusions can be reached now.



Largest refinery in Bolivia is this one at Cochabamba. It has a 5850 bbl per day capacity. Only YPFB has refineries.

Exploration and Drilling

Bolivian Gulf was awarded 1,235,500 acres of exploitation concessions in the Santa Cruz area of Zone I, and 2,718,000 acres of exploration concessions in Zone II, northwest of Todos Santos in February 1957. This followed Gulf's acquisition of an operating interest in some 3,706,500 acres in the Parapetí area of southern Bolivia from YPFB, the government petroleum agency, in 1956. In July of that year Gulf began exploration activities, completing 18,000 square miles of aerial photography by Hycon Aerial Surveys together with an airborne magnetometer survey by Aero Service.

Field geological studies were likewise initiated and continued at an accelerated pace in 1957 with the assistance of helicopters supplied by Petroleum Helicopters, Inc. In early 1957, Seismograph Service began a gravimeter survey of Gulf's Parapetí area, facilitated by extensive bulldozing and clearance operations. Photographic coverage was augmented by flying an additional 15,000 square miles. In late 1957, Gulf applied for an additional 988,402-acre concession in Zone II.

Shell, Andes Oil (Pure, Sohio, Hancock), Bolivian Petroleum, and Fish Engineering are working on geology or making geophysical surveys.

There are 15 geological crews: Gulf has 3, Chaco 5, Shell 4, and Standard of California 3.

Five gravity, 5 seismic, and 1 magnetometer parties are at work. In Bolivia the cost of these exploration crews average about $8500 a month.

Besides the three McCarthy wells, only actual drilling done by foreign companies since 1937 are at Chaco Petroleum No. 5 Los Monos, which is waiting on equipment for completion, and at Bolivian Gulf's Mandeyapecua No. 1 wildcat.

The latter was spudded February 7 southeast of the Camiri field. This 15,000-ft test is being drilled with the company's National 130 rig brought into Southern Bolivia from Buenos Aires by rail. Gulf plans additional wildcat starts.

One well at Los Monos on the Chaco lease drilled by McCarthy is capable of producing small amounts of 54 deg gravity oil. Tennessee Gas had the oil analyzed and found it to be ideal diesel fuel for the drilling rig with no processing other than weathering in the stock tanks for approximately three weeks.

Chaco Petroleum also spudded a deep test, Agua Salada No. 1, in June. It is scheduled for a 12,000-ft depth to test the Tupambi sand (Permian). Loffland Bros. are the contractors.

Other concessions are in various stages of exploration prior to actual drilling operations.

Present Production

Although Bolivia is one of four South American nations that has net exports of petroleum, production is small.

Daily average production of oil at present is 9900 bbl per day, all of which is produced by YPFB. Eleven rotary rigs are operated by YPFB to develop its fields. Table 2 shows the fields from which this production is obtained.

Refining

At the present YPFB owns and operates all refineries in Bolivia. Their location and capacity are listed in Table 3.

Pipelines

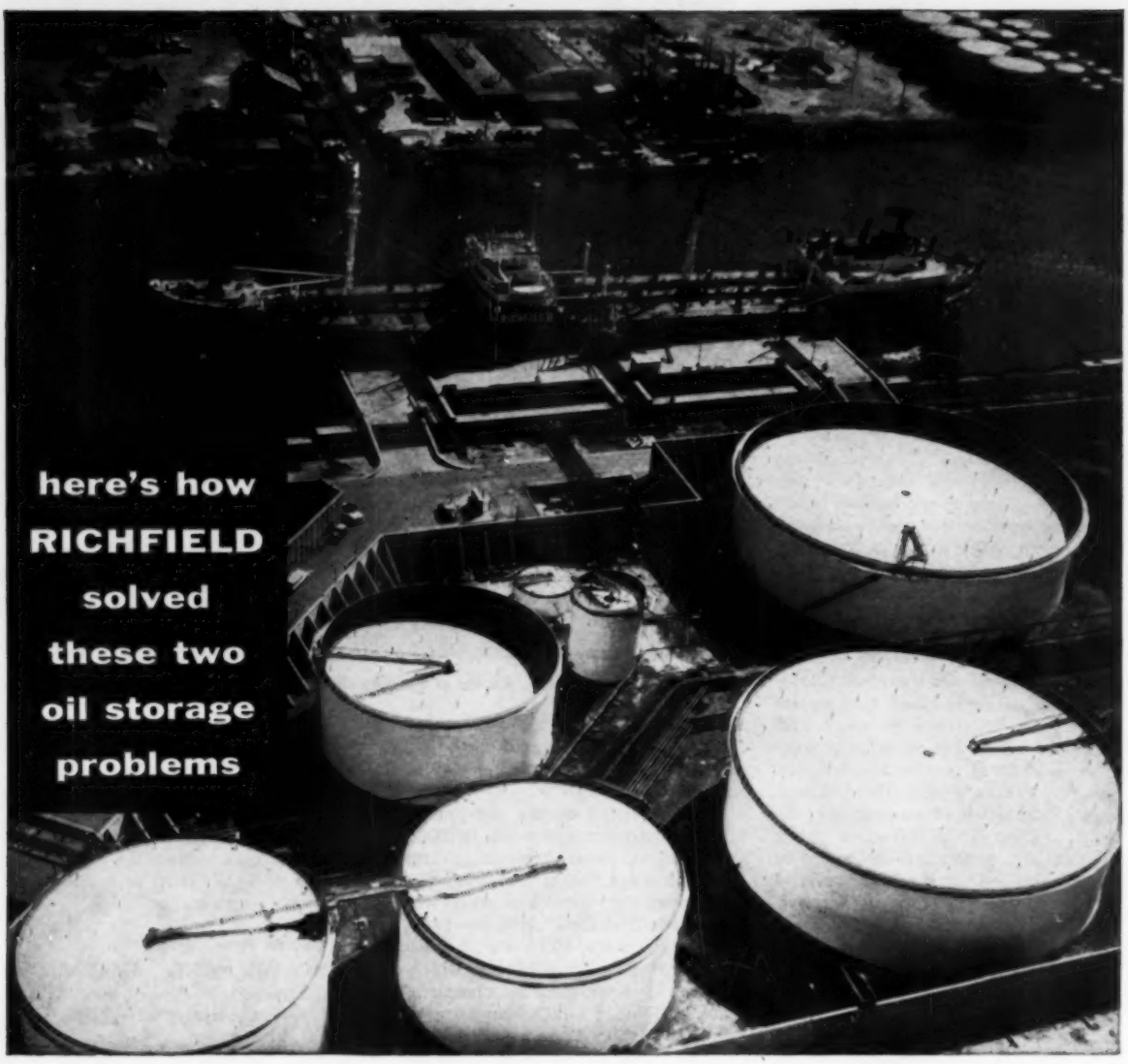
Pipelines are the key of Bolivia's industry. Production more than meets the 6960 bbl per day consumption and

TABLE 2. Bolivian Production.

Name of field and discovery year	Depth, ft	Number of wells flwg.	Number of wells pmpg.	Daily prod. bbl	Gravity API
Bermejo, 1922	3600	7	5	600	26-27
Camiri-Guairuy, 1926-46	4400	46	6	8600	54-59
Sanandita, 1926	3100	—	13	100	41.0
Toro, 1955	4100	3	—	600	21-54
TOTAL		56	24	9900	

TABLE 3. Refineries in Bolivia.

Refinery location	Bbl/stream day
Cochabamba	5,850
Sucre	4,000
Camiri	2,000
Sanandita	500
Bermejo	200
TOTAL	12,550



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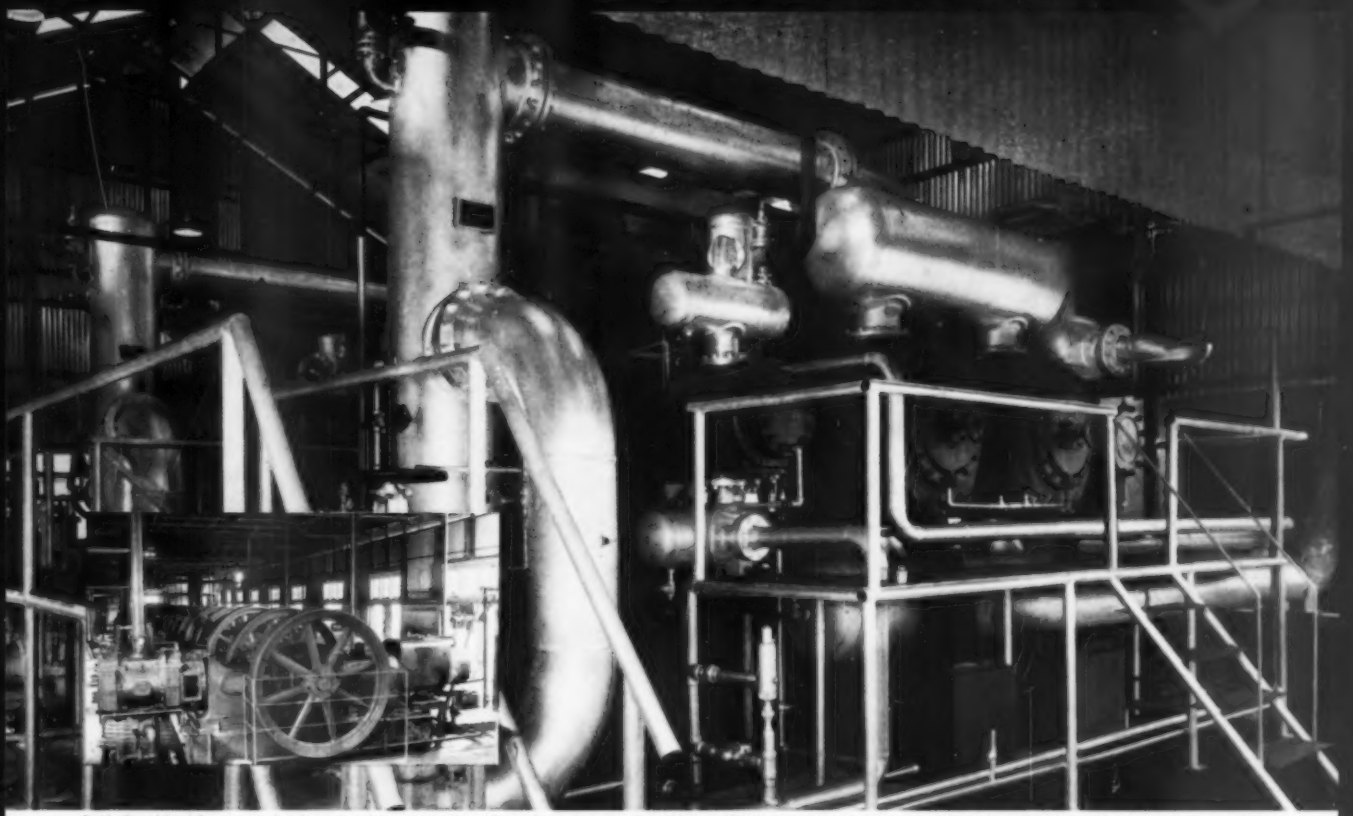

Caddo Pine Island Corporation Gas Processing Plant—equipped with two Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors. Units have Young Radiators with gas, lubricating oil and engine water cooling sections. Other sizes 120 to 660 h.p. Inset picture shows original horizontal compressors.

Caddo Pine Island Corporation processes flare gas from 1,000 Pine Island Field wells in an absorption plant located near Oil City, Louisiana. Picking its load up over a thirty mile gathering system, the plant was originally equipped with twenty horizontal compressor units. These have now been replaced by two Beaird-Ingersoll-Rand 12SVG 660 h. p. packaged compressors.

Using three stages of compression the packaged units pull the gas into the plant under ten inches of vacuum. It is then boosted through processing operations and returned for third stage boosting to the sales line. Up to 5¼ million cubic feet can be handled per day with final delivery pressures of 440 psi.

Installation of modern Beaird packaged compressors has increased plant dependability and lowered fuel, labor and maintenance costs. An additional savings will be realized when the field is depleted. Installation of packaged compressors has made the station almost wholly salvable.

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TABLE 4. Exports.

	Bbl/day
Argentina	2761
Chile	296
Brazil	300
Paraguay	6
Peru	137
Total	3500

markets are far away in this landlocked country. In 1957 a 4½-in., 167-mile crude oil line was built from Camiri to Santa Cruz, on the railroad to Brazil. A 216-mile, 8½-in. and 10½-in. line from Sicasica to the port of Arica, Chile, was completed in October by YPFB. Bolivian Gulf is meeting part of the $12 million cost.

Argentina receives 2000 bbl per day from Camiri and Sanandita fields by way of a 6-in. line. Several pipelines are proposed.

It must be remembered that the Bolivian Government sets prices on products. Perhaps the chief reason consumption has not risen as rapidly as in some neighboring countries in the last two years is that prices were pushed up sharply. YPFB had been pricing products far below cost. Gasoline prices were raised in December 1956 from 7 cents a gallon to 25 cents.

Exports during 1957 by countries are shown in Table 4.

The Country Itself

Bolivia is the fourth largest nation in South America with a total area of 413,000 square miles—equivalent to the combined areas of Texas, Oklahoma and New Mexico. The country is landlocked with no outlet to the sea and more than two-thirds of the population of 3½ million live in about 12,000 ft altitude in the Andes or on the Altiplano, a windswept plateau completely fenced in by Andes Mountains.

More than 60 percent of the population of Bolivia are Indians who speak their own language, although some in the urban areas also speak Spanish, the official language of the country.

La Paz is the government seat of Bolivia, the highest capital city in the world with a range in elevation from 13,400 ft to 12,000 ft. It has a population of 400,000. El Alto, airport for La Paz is the highest commercial airport in the world—13,250 ft elevation. Most oil companies operating in Bolivia have offices or representatives in La Paz.

Cochabamba, founded in 1574, is the second largest city in the republic with a population of 100,000 people. This colorful, modern city is becoming the oil center of Bolivia. The Bolivian subsidiaries of Tennessee Gas, Gulf, California Standard, and several of the geophysical companies have their main offices in Cochabamba.

Beautiful La Paz, highest capital city in the world, has a population of 400,000 people.

The primary reason for this is the central location of Cochabamba in relation to exploration activities. In addition, the climate in Cochabamba at an altitude of about 8500 ft, is quite similar to that of Mexico City. Office and housing facilities are readily available in Cochabamba at the present time although they are tightening.

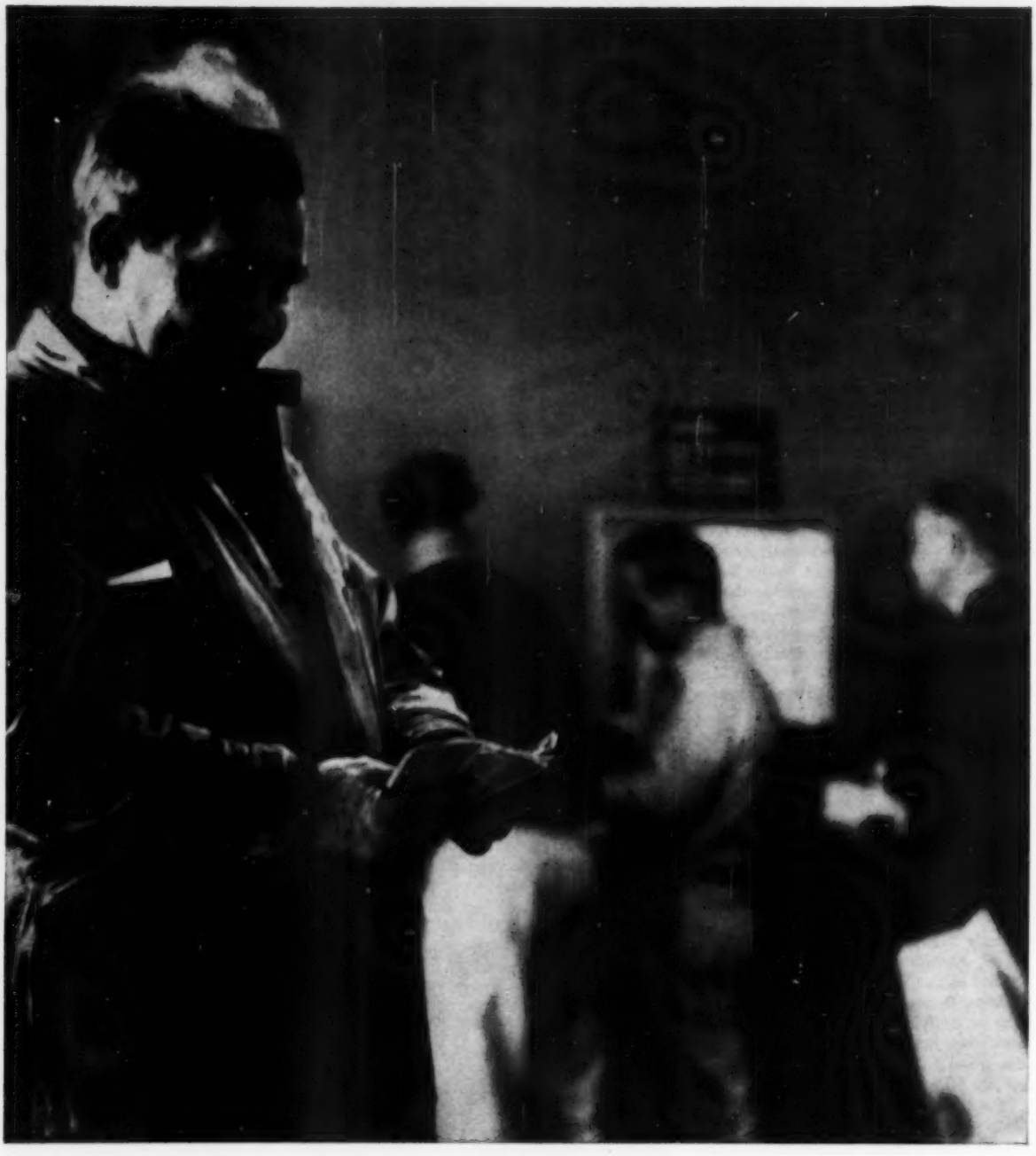
The city of Santa Cruz is growing more important from an exploration standpoint because of its proximity to many of the exploration concessions. An excellent hard surfaced highway 312 miles long connects Santa Cruz with Cochabamba.

In the opinion of some observers on the scene, there is some recognition of the importance of foreign capital in developing oil in the country. There are also radical socialists who would again nationalize the oil industry as they did the mining industry. The practical failure of this move has not penetrated the heads of the leftists. It would not take much to totter the slight hold capitalism now has.

It is difficult to judge the returns so far on concessions. A typical one is the recent Fish Engineering contract for a 98,840-acre concession. Profits will be split 50:50. Fish Engineering is to pay Bolivia $1,500,000 within six months of date of contract and $2,500,000 as advance payment of anticipated future royalties. It also granted credit to Bolivia totaling about $13,750,000. All this for rank wildcat leases.

If exploration is successful, that is only the beginning. Markets must be found, pipelines and refineries built. To make investments of this size, those with capital must have a reasonable expectation of political stability. ★ ★

Ceremonies marking the building of a pipeline from Sicasica, between La Paz and Oruro, to Arica, Chile, a seaport. This will move oil to the coast for export.



"Americans getting their weekly pay checks from the production of merchandise for foreign markets number many more than are liable to be displaced by imports from other countries. The encouragement of trade with all the countries of the free world is a basic ingredient for peace."

—Eugene Holman, Chairman of the Board, Standard Oil Company (New Jersey)

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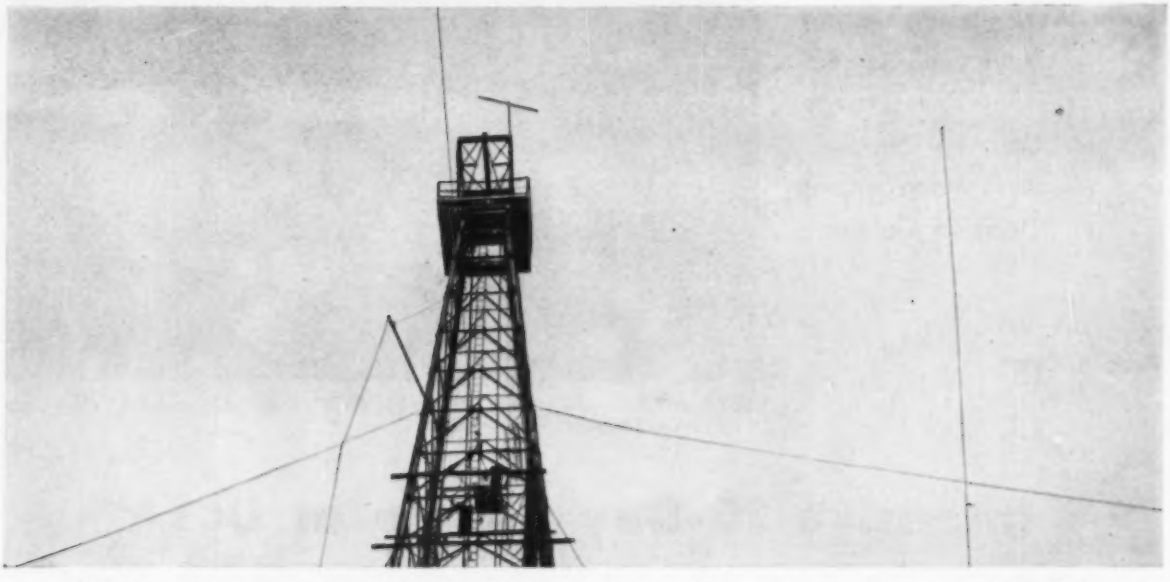

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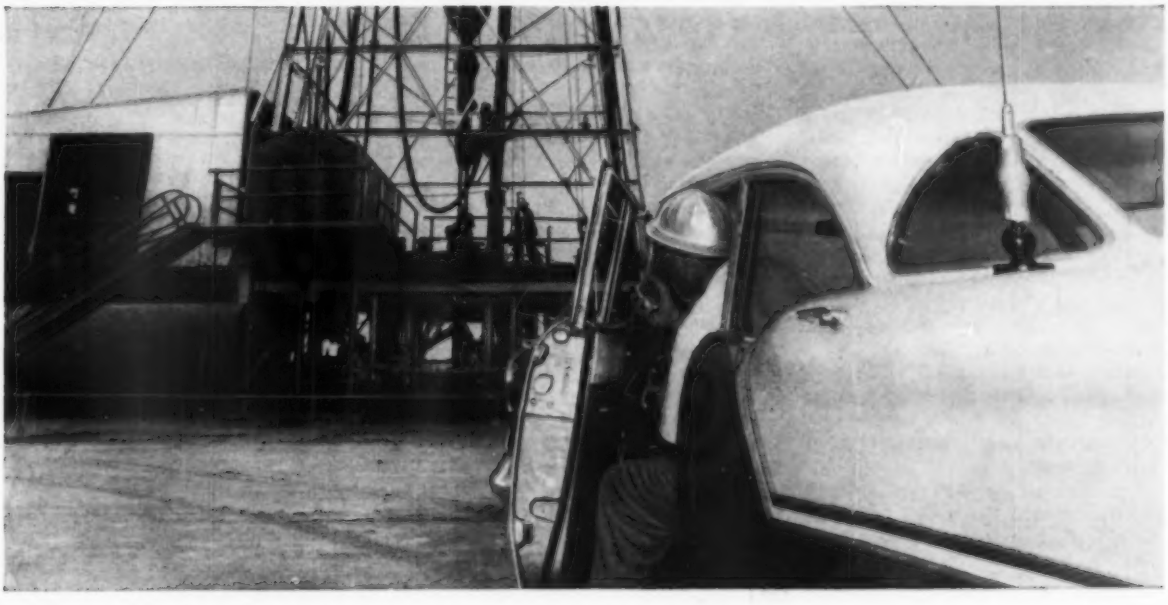

Early course in engineering and management has developed such subjects as "Creative Thinking" and "Business Management Decision Gaming"

Reno R. Cole*

Dr. Robert Tannenbaum, standing, discusses proposed demonstration session by a sub-group in his class in "Leadership Principles."

Intensive 10-Day Course at UCLA

THE Engineering and Management Course, an intensified 10-day short course for industrial engineers and managers, will be given for the fifth time on the campus of the University of California, Los Angeles during the period January 26 to February 5, 1959.

The course is historically interesting in that it is a descendent of one of the first of such courses given in this country, having been originated at the University of Iowa by Professor Ralph M. Barnes in 1939.

Professor Barnes was instrumental in organizing a modernized version of the course when he moved to UCLA and the first presentation of the redesigned course was made in 1955. Inspection of the subjects of instruction for the 1959 course show that both classical engineering and management classes and classes in newly developed quantitative techniques of management are offered. A participant may select four of the subjects plus an optional early morning voice laboratory and a late afternoon public speaking class. There is a 1½ hour instruction period in each subject daily for the 10 days plus a series of luncheon and dinner lectures by outstanding speakers.

The course is revised yearly to keep it abreast of rapid developments in engineering and management. Classes newly added this year include "Case Studies in Business Management," a companion course to "Business Management Principles," "Business Management Decision Gaming" and "Creative Thinking in Engineering and Management."

The course in "Business Management Decision Gaming" has been designed to give business managers 10 years of simulated business problem experience during the 10 days of the course. Participants will be organized into teams, each representing a business concern. All facts regarding the particular business are given to the team members who then make decisions regarding such things as funds to be expended on sales promotion, research, replacement of equipment, etc. These decisions will then be fed into an IBM 709 computer and the results of the decisions returned to the teams for use in planning the next "year's" operations.

The class in "Creative Thinking" will be taught by three outstanding men who have written and thought extensively on the subject and will attempt to get participants started in doing their own creative thinking in their engineering and management activities.

A typical participant is between the department head and general manager level, or the corresponding engineering levels, has about 200 subordinates and 2 to 4 staff assistants. He seems to fall into one of three groups with respect to his need for such a course: He has either come up the ranks through some speciality and now finds himself with more general responsibilities requiring a wider knowledge or he has been too busy to keep abreast of the rapidly advancing management field. There is also a group of younger men who are being groomed for greater responsibility, who seem to find the course helpful.

While most of those attending the course are from the western part of the United States, participants have come from all over the United States, Hawaii, and from foreign countries such as New Zealand, Holland, Scandinavia, and South America.

There are no prerequisites for the course. An inquiring and flexible mind and desire to participate in a free exchange of knowledge and experience is more important than formal education.

Course fee is $400 which includes 10 lunches, one dinner, texts, all course materials and use of the university library and laboratory facilities.

Information and illustrated course brochure can be obtained by writing to Reno R. Cole, Coordinator, Engineering and Management Course, Department of Engineering, Room 3104, University of California, Los Angeles 24, California.

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Digital Computers for the Industrial User
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*Professor of Engineering, University of California, Los Angeles and Coordinator, Engineering and Management Course.

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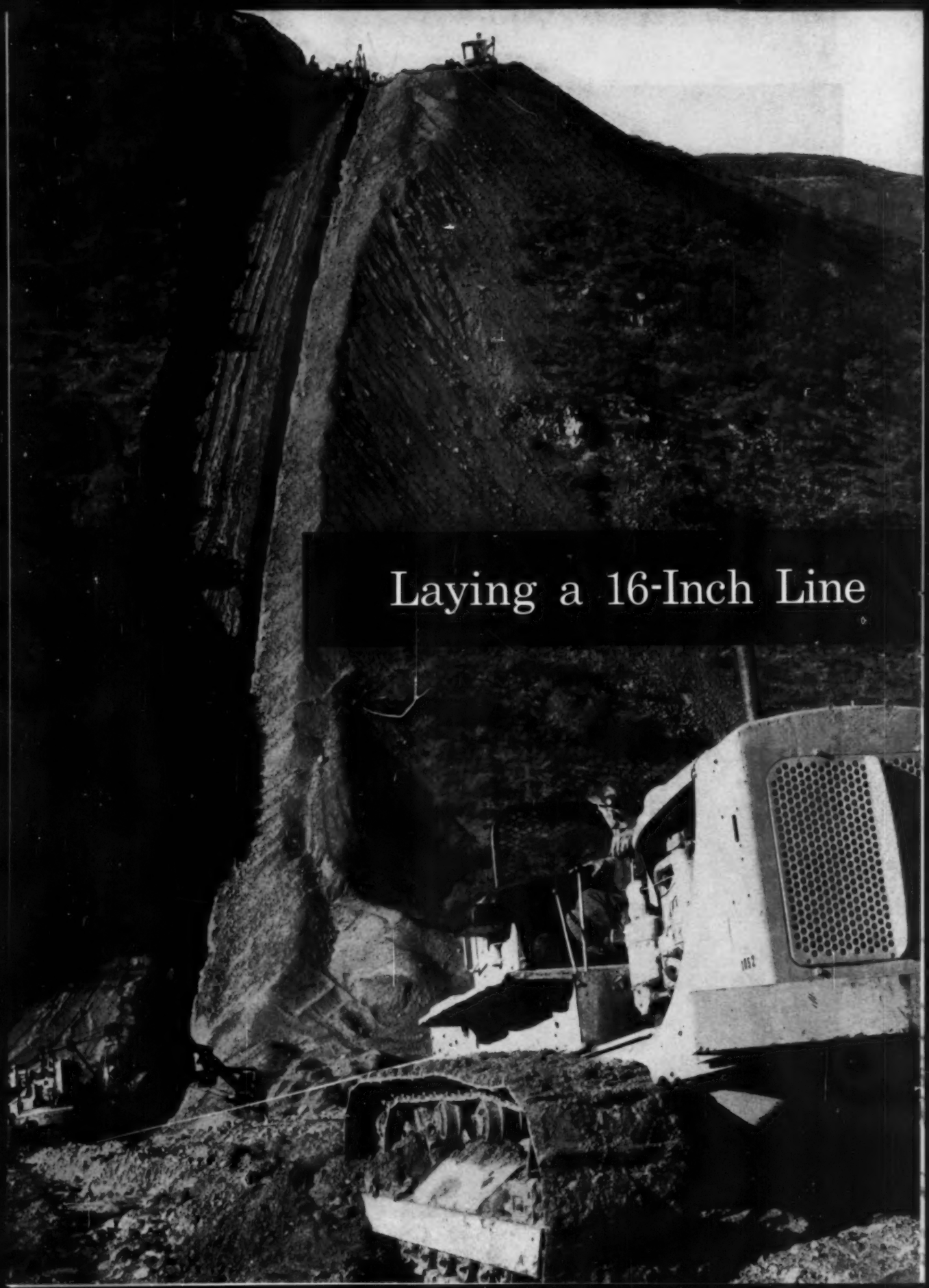

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A fleet of sure-footed Caterpillar crawler Tractors —D7s, D8s and D9s—are doing the pioneering work. Equipped with bulldozers and rippers, they 'doze a load down one of the steep grades and are pulled back by a D8 with a Hyster winch. The ditcher is pulled up the young mountains by the winch on a D8 and let down the far side.

Filling out the spread on this section are four Cat Twin Arc-Welders, nine Pipelayers and a No. 12 Motor Grader.

On the toughest pipeline jobs throughout the world, Caterpillar yellow is always the predominant color of the equipment. Pipeliners know from field experience that wherever the pipe takes them, Caterpillar equipment will get them through.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U.S.A.

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

MAN-SIZED PIONEERING — Two giant D9s bulldoze and rip the rocky soil for the ditcher. One D9 is equipped with a Kelley Ripper while the second uses a matching No. 9 Ripper.

A LIFT FROM A D7 — A backhoe is winched up a 75% grade by a D7. Atop the hill in the back are two D8s with a winch and a Caterpillar MD7 with a pneumatic drill.

Management Personals

W. S. S. Rodgers, former president and retired chairman of the board of directors of The Texas Company, was named the 1958 recipient of the American Petroleum

W. S. S. Rodgers

Institute's "Gold Medal For Distinguished Achievement."

William Starling Sullivant Rodgers started in the oil business in 1911 as a roustabout and tool dresser, and more than 40 years later retired as chairman of the board of directors of Texaco. At 72, he still serves as a member of the Texaco board of directors, and of the board's executive committee. He became Texaco's president in 1933. Even with the depression still hanging over business, within 8 months after he became president Texaco was again in the black. Rodgers was elected chairman of the board of directors in 1944 and served in that position until 1953, 2 years after normal retirement age.

J. Ed Warren was elected chairman of the executive committee and member of the board of directors of Cities Service Company. Warren resigned as senior vice president of the First National City Bank of New York, with which he has been associated since 1953. He was also appointed a director of City Bank Farmers Trust Company.

H. S. M. Burns, president of Shell Oil Company and chairman of the board of directors of the American Petroleum Institute, has accepted the presidency of the 1959 World Petroleum Congress.

W. Edwin Cox was designated manager of public relations for the Lion Oil Company division of Monsanto Chemical Company. Cox replaces **K. W. Dodson Jr.**, who has elected early retirement from the company in order to become director of public relations for the Murphy Corporation. Cox has been manager of sales training.

Lee N. Haugen, formerly vice president and general manager of Cit-Con Oil Corporation was elected vice president, general manager and member of the board of directors of Cities Service Research and Development Company. Haugen succeeds Walter W. Scheumann, who died October 5.

George A. Whittington, managing editor of *Automotive Service Digest*, Chicago, has been elected president of the Technical Writing Improvement Society, national organization of educators, editors and engineers interested in improvement of scientific communication. **Ernestine Adams**, management edition editor of *The Petroleum Engineer*, Dallas, was elected vice president.

Elected members of the executive committee were **Prof. Jay R. Gould**, director of the Technical Writers' Institute at Rensselaer Polytechnic, Troy, New York, and **John L. Kent**, advertising and public relations manager, Datex Corporation, Monrovia, California.

Jerry Lubovski was named director of public relations and advertising for Union Oil Company of California. He had been manager of public affairs.

Paul W. Sheldon, formerly a supervisor in the public relations department of Young & Rubicam, Inc., New York, has joined Gulf Oil Corporation's public relations department.

P. S. P. Fell was appointed New York representative, crude oil department, Gulf Oil Corporation. **R. C. Arnold** was appointed South American representative, crude oil department.

Fell joined Gulf in 1956, as the New York representative of the foreign crude oil sales department, and has served in that capacity for Gulf since his employment. Arnold joined Gulf's Louisville division office in 1922. He became the foreign crude oil sales department representative, stationed in Rio de Janeiro, Brazil, in 1955.

L. Russell Marks was elected executive vice president, Murphy Corporation. He has been vice president—finance and service since 1955 and formerly was associated with C. H. Murphy, Sr. and members of his family in several business enterprises. **J. A. O'Connor Jr.** was elected vice president. He has been secretary and general counsel since 1954.

E. H. Tollefson, executive vice president of the Consolidated Natural Gas Company, was elected chairman of the board of trustees of the Institute of Gas Technology, affiliate of Illinois Institute of Technology.

Seven trustees were re-named to the board and six new trustees elected. **Lester T. Potter**, president, Lone Star Gas Company, and **Charles M. Sturkey**, president, Washington Natural Gas Company, were elected to 3-year terms on the board.

Emerson G. Smith, director of public relations of the Continental Oil Company, was elected secretary of the Public Relations Society of America, Inc. **Tom Brawner** of The Texas Company, was elected a national director.

Don Riddle, public relations representative for Gulf Oil Corporation, has announced retirement effective January 1 after more than 25 years' service with the company. He will offer his services as a consultant to the petroleum industry. Riddle and **James A. Clark**, oil writer and consultant, will be associated in the enterprise, with offices in the Oil and Gas Building in Houston, Texas.

Stanley D. Breitweiser, vice president of D-X Sunray Oil Company, was elected president of the new Oklahoma Petroleum Council for a full two-year term. **F. C. Fellingham**, Pan American Petroleum Corporation, was chosen vice president, and **James O. Kemm**, executive manager of the OPC, was elected secretary treasurer.

Norman Hardy, president of Arabian American Oil Company, was designated chief executive officer. **Fred A. Davies** will continue as board chairman.

Seven Aramco vice presidents were elected to the board of directors: **P. H. Arnot, T. C. Barger, R. I. Brougham, R. A. Eeds, R. S. Hatch, J. H. McDonald** and **L. M. Snyder.**

Norman Hardy

F. O. Sharp Jr.

Fred O. Sharp Jr., was appointed general manager of Feldman Oil and Gas and executive vice president of Worldwide Petroleum Corporation, Ltd., the company responsible for the international operations of the Feldman organization. He was formerly executive assistant and coordinator.

Robert F. Baldaste was appointed assistant manager of the organization department of Standard Oil Company (Indiana). With Standard for more than 19 years, he was formerly administrative director of the Whiting research laboratories, and more recently has been assigned on a temporary basis to the company's organization department in the Chicago general offices.

DEATHS

Burton E. Hull, 74, retired president of the Texas Pipeline Company and three other Texas Company subsidiaries, died November 8, following a long illness.

Lloyd Pickrell, independent producer-contractor and head of Pickrell Drilling Company, died early in November.

J. W. Cason, vice president and treasurer of Interstate Oil Pipe Line Company, died October 11 as a result of a heart attack.

Dr. Oscar E. Bransky, 72, former chief of the petroleum branch of the Economic Cooperation Administration (Marshall Plan) and retired assistant general manager of manufacturing of Standard Oil Company (Indiana), died October 1, at Palm Beach, Florida.

Walter W. Scheumann, 57, vice president and general manager, Cities Service Research and Development Company, died October 5.

Dr. Kenneth Albert Kobe, outstanding member of the University of Texas chemical engineering department for 17 years, died November 2 of a cerebral hemorrhage.

G. A. Montgomery died in July in Buenos Aires, Argentina. He was well-known in the oil tool industry in California, Texas, and Wyoming fields. Among his fifty-odd patents was the cable tool under-reamer assigned to The Guiberson Corporation.

Howard A. Grimes, 56, a retired director of Creole Petroleum Corporation, died October 27 in Dunedin, Florida.

• News • People — The Trade PARADE

THE AMERICAN METER Company, manufacturers of gas meters and industrial instruments, reported that its subsidiary, Buffalo Niagara Industrial Controls, Inc., has purchased the Buffalo Meter Company of Buffalo, New York. Buffalo Meter has manufactured water meters for homes and industry for over 65 years at its 100,000 sq ft plant in Buffalo. W. G. Hamilton Jr., president of American Meter, will serve as president of the new subsidiary. Dante Broggi, a vice president of American Meter, will direct the operations of the new acquisition through Russell Wetjen, who will be vice president and general manager. Herbert F. Barrett will continue as sales manager.

GRAVER WATER Conditioning Company has announced the appointment of G. M. Wallace & Company as engineering representatives for the Rocky Mountain—Intermountain area. They will handle Graver's complete line of equipment for industrial, utility and municipal water treatment, industrial waste treatment and chemical processing.

ALASKA'S first oil industry servicing depot, and Houston Oil Field Material Company, Inc.'s 55th installation in its world-wide network, is now in operation in Anchorage. Under the direction of Oil Equipment, Ltd., a wholly-owned subsidiary of HOMCO, and C. L. (Hal) Roach, vice president in charge of Canadian operations, the Anchorage depot is equipped with a complete line of directional tools, fishing tools, bumper jars, overshots, bumper subs and a string of wash pipe.

COMPLETION of an arrangement under which Perforating Guns Atlas Corporation, Houston, will offer the continuous velocity logging and seismic calibration services of Seismograph Service Corporation, Tulsa, has been announced. The companies state that this arrangement offers PGAC's clients the services of the most experienced organization in the acoustical logging field, together with the benefits of the integrated electrical, induction, and nuclear logging facilities, and complete perforating and other wireline completion services of PGAC.

THE MILWHITE COMPANY, INC., of Houston, Texas, announces that on or about January 1, 1959, it will introduce new high efficiency acid activated clay adsorbents for oil refiners and other process industries.

The Milwhite Company has contracted with Morton Chemical Company, of Chicago, Illinois, for the latter to manufacture these adsorbents by a Milwhite process. The clay activation unit is now being erected adjacent to the Morton Chemical acid plant at Weeks Island, Louisiana. It is the first acid activation plant in the U. S. to employ hydrochloric acid.

THE GEOTECHNICAL CORPORATION recently moved into a new 40,000 sq ft plant located at 3401 Shiloh Road, Garland, just north of Dallas, Texas. The move enables Geotech to strengthen and expand its position in the field of research, design, and manufacture of electromechanical instrumentation.

NEGOTIATIONS have been completed by Republic Steel Corporation for the reacquisition of Republic Supply Company. Republic Supply, with headquarters in Oklahoma City, Oklahoma, operates oil country supply stores and pipe yards throughout the Mid-Continent area.

TO SPEED UP and expand product development, Hughes Tool Company has created a product observation division within the product engineering department. R. R. Aulick, who has had extensive engineering experience with Hughes and has directed the activities of the sales engineers in the northern region, heads the new division as manager.

The initial assignments to the new product observation division included the following regional field engineers: W. A. Kistler Jr., to Midland, Texas; A. G. Rollow to Oklahoma City; R. D. Jones to Wichita Falls, Texas; R. O. Bredthauer to Houma, Louisiana; Joseph A. Kloesel Jr., to Farmington, New Mexico.

MINNEAPOLIS-HONEYWELL Regulator Company has expanded manufacturing facilities at Beltsville, Maryland, for high-speed data-recording equipment. Plant capacity has been increased by 40 percent, permitting re-arrangement of operations that virtually doubles production space. The Beltsville plant is a unit of Honeywell's industrial products group headed by vice president Henry F. Dever. It employs approximately 250 persons.

look to the HEART!
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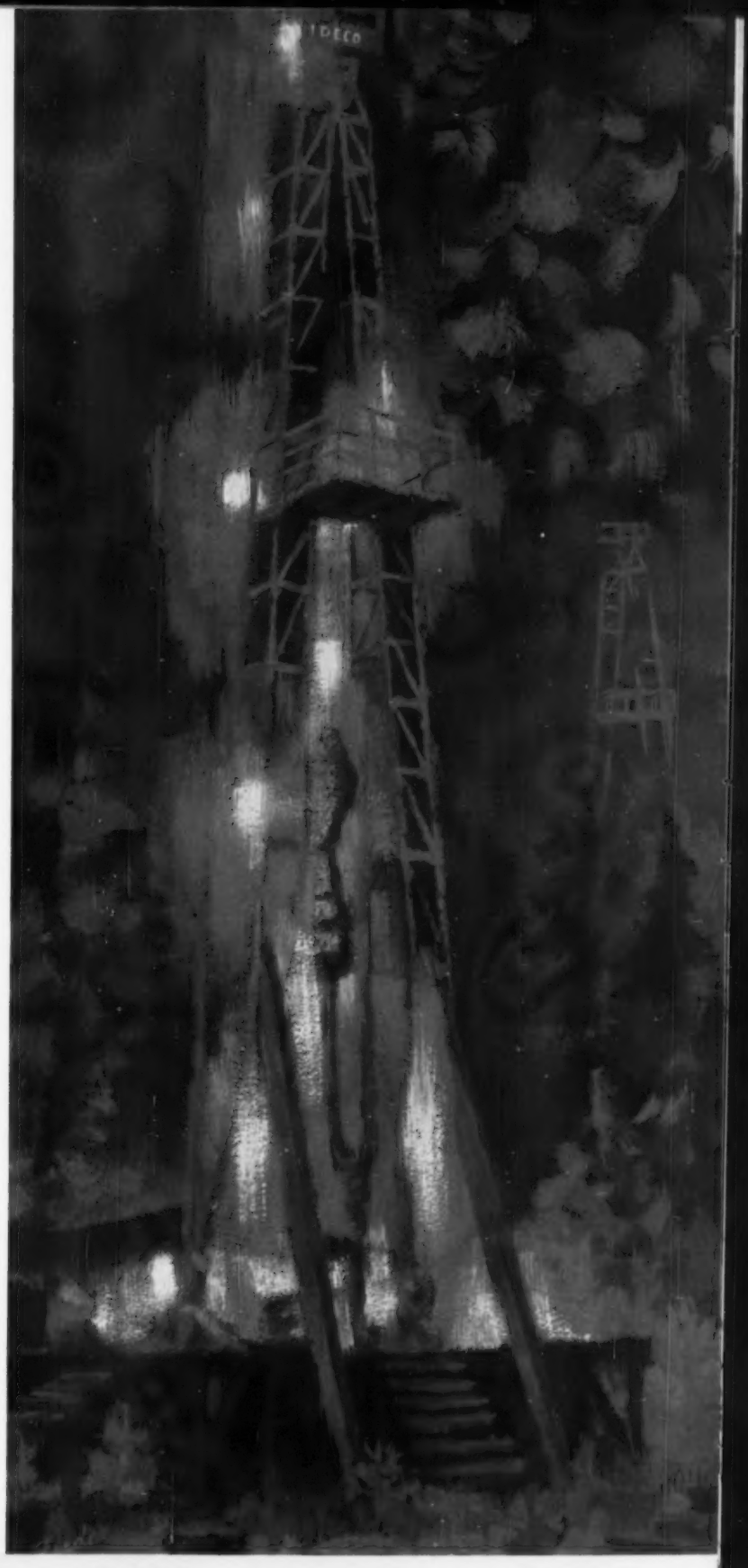
HUMAN OR MECHANICAL
IT MUST BE
STRONG, DEPENDABLE
AND HEALTHY
smooth running . . . with remarkable endurance in any weather to handle changeable loads . . . WISCONSIN conservatively rated, heavy duty engines are healthy "mechanical hearts" for constant, economical service to power your equipment.
WE HANDLE THE COMPLETE LINE OF WISCONSIN AIR-COOLED ENGINES AND PARTS . . . 3 hp. to 56 hp.
CONTACT YOUR NEAREST DEALER OR
HARLEY
SALES COMPANY
WICHITA TULSA HOUSTON
The above EKG is an actual reproduction of a sound human heart. If such data for a WISCONSIN engine could be so plotted, the resemblance to this sound power plant would be striking.
not on order... but on the way!

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



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compressors and gas turbines

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DIVISION—couplings

GUIBERSON

THE GUIBERSON CORPORATION
oil tools

Hermetic Seal Transformer Co.

HERMETIC SEAL TRANSFORMER CO.
electronic transformer development

IDECO Inc.

IDECO, INC.
drilling rigs

GREETINGS . . .

Peace on Earth to Oilmen Everywhere in an industry that is just completing its first century of service to mankind in making the world a better place to live, love and work.

MERRY CHRISTMAS

LANE-WELLS COMPANY
technical oilfield services

MAGNET COVE BARIUM CORP.
drilling mud

PACIFIC PUMPS, INC.
pumps

ROOTS-CONNERSVILLE BLOWER DIVISION
blowers and motors

SECURITY ENGINEERING DIVISION—drilling bits

SOUTHWESTERN INDUSTRIAL ELECTRONICS
electronic instrumentation

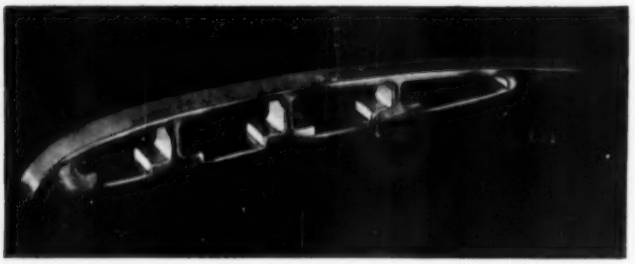
WELL SURVEYS, INC.
nuclear and electronic research

SAFER for FLAMMABLES

NEW LUFKIN "JET" TAPE

Here's the *safer* tape the oil industry needs for jet fuels. Stainless steel line is Chrome Clad®. Handle is wood. All other parts are non-sparking metals. See your Lufkin dealer for this new oil gaging tape.

THE LUFKIN RULE COMPANY
TAPES • RULES • PRECISION TOOLS
SAGINAW, MICH. • MIDDLETOWN, N. Y. • BARRIE, ONT.



Cross section shows structural superiority of Aeromaster's new, extruded aluminum-alloy blades in diameters from 9' to 22'.

NEW! EXTRUDED ALUMINUM Blades on AEROMASTER* fans only

AEROMASTER'S new, extruded aluminum blades combine in one design the advantages of a light weight metal, a hollow structure and the superior strength of wrought metal... Silicon-magnesium aluminum alloys resist corrosion. Their fine grain structure, high tensile strength and increased endurance eliminate danger from wear, vibration, and metal fatigue... true airfoil blade sections assure maximum air delivery... adjustable blade pitch angle permits decrease of fan load to an accurate minimum horsepower requirement.

The AEROMASTER fan is easily assembled *in the tower.* No special handling equipment is necessary. AEROMASTER fans cost less to install, less to operate, less to maintain!

For more details write to KOPPERS COMPANY, INC., Aeromaster Fan Dept. 6712 Scott Street, Baltimore 3, Maryland.

KOPPERS Aeromaster Fans
Engineered Products Sold with Service

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Trade Parade

MILWHITE MUD Sales Company has announced two new zones in their sales and service organization. The Mid-Continent Zone, which includes Kansas, Oklahoma, North Texas, West Texas, and New Mexico, is under the supervision of Richard Ladd of Tulsa, Oklahoma. Ladd will continue to make his headquarters in Tulsa. The Rocky Mountain Zone will service the Four Corners area up to the Canadian Rockies. R. J. "Bob" Adamson, formerly of Casper, Wyoming, will be in charge of this zone and make his headquarters in Denver, Colorado.

THE BORG-WARNER CORPORATION has formed a new division to manufacture, sell and service the Borg-Warner mechanical seal. The demand for this product line, formerly the BJ mechanical seal, has made it necessary to establish it as a separate industrial product division of Borg-Warner.

DE LAVAL SEPARATOR Company has moved its Chicago headquarters to 5724 N. Pulaski Road. Costing nearly $1,000,000, the new De Laval building was designed and built to the company's specifications. It is located on a 4½-acre tract and has 64,000 sq ft. Fully air conditioned offices comprise 17,000 sq ft. It will also provide warehouse and repair service facilities.

BLACK, SIVALLS & BRYSON, INC., has announced that headquarters for sales management of BS & B's oilfield equipment division were established at Houston, with the transfer of Floyd C. Myers, vice president and manager of oilfield sales and service, to that location. All other oilfield division departments remain headquartered at Oklahoma City.

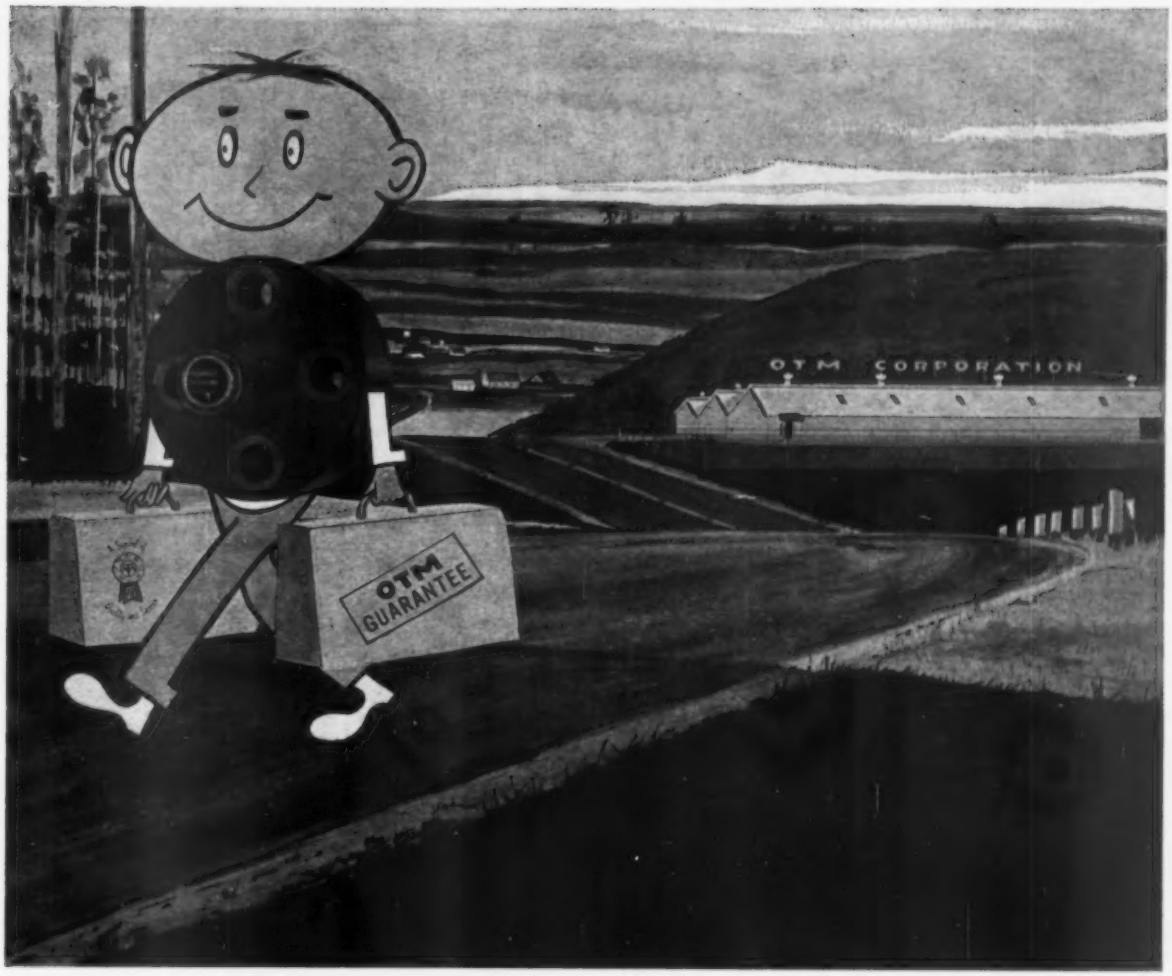
THE FORMATION of a wholly-owned international subsidiary company under the name of Compania De Laval Turbina Internacional, S. A., has been announced by De Laval Steam Turbine Company, Trenton, New Jersey. The main offices will be in Panama, R. de P. The new company will coordinate and promote the sale and servicing of De Laval products throughout the world, except the United States, Canada, Hawaii and Puerto Rico.

De Laval also announced the formation of De Laval Turbina de Mexico, S. A., a subsidiary of the Panamanian company, with headquarters in Mexico City, D. F. J. P. Stewart, of Trenton, is president and Richard M. Cueto is sales manager.

PLANS FOR combining Mayhew Machine Company, Inc., and Mayhew Supply Company, Inc., both of Dallas, with Gardner-Denver Company, Quincy, Illinois, have been announced. Mayhew Machine is a producer of seismograph and geophysical drilling equipment for the oil industry, and manufactures light oil well drilling rigs and rotary drilling equipment for the construction and mining industries. Mayhew Supply is the sales organization that markets these products. Gardner-Denver is a manufacturer of equipment for the petroleum, mining, construction, and manufacturing industries.

B-I-F INDUSTRIES, INC., has opened new regional sales offices at 256 Peachtree Boulevard at Florida Street in Baton Rouge, Louisiana. The offices are headed by Lewis H. Johnson Jr., and will handle the products of B-I-F Industries and its three divisions — Builders-Providence, Inc., Proportioneers, Inc., and Omega Machine Company.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



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. . . and he's carrying his OTM Blue Ribbon Guarantee. Every OTM Blue Ribbon Product (flange and fitting) is backed by the OTM Blue Ribbon Guarantee — the most comprehensive written guarantee in the industry. **Perfection Plus** is the pre-requisite in earning the Blue Ribbon Guarantee, and OTM insures perfection by use of Magnaflux*, Reflectoscope*, Brinell Meter and Profilometer inspections. **AND NOW!** OTM Blue Ribbon welding-neck and slip-on flanges are centerlined*.

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** FIRSTS IN THE INDUSTRY FROM OTM CORPORATION.*

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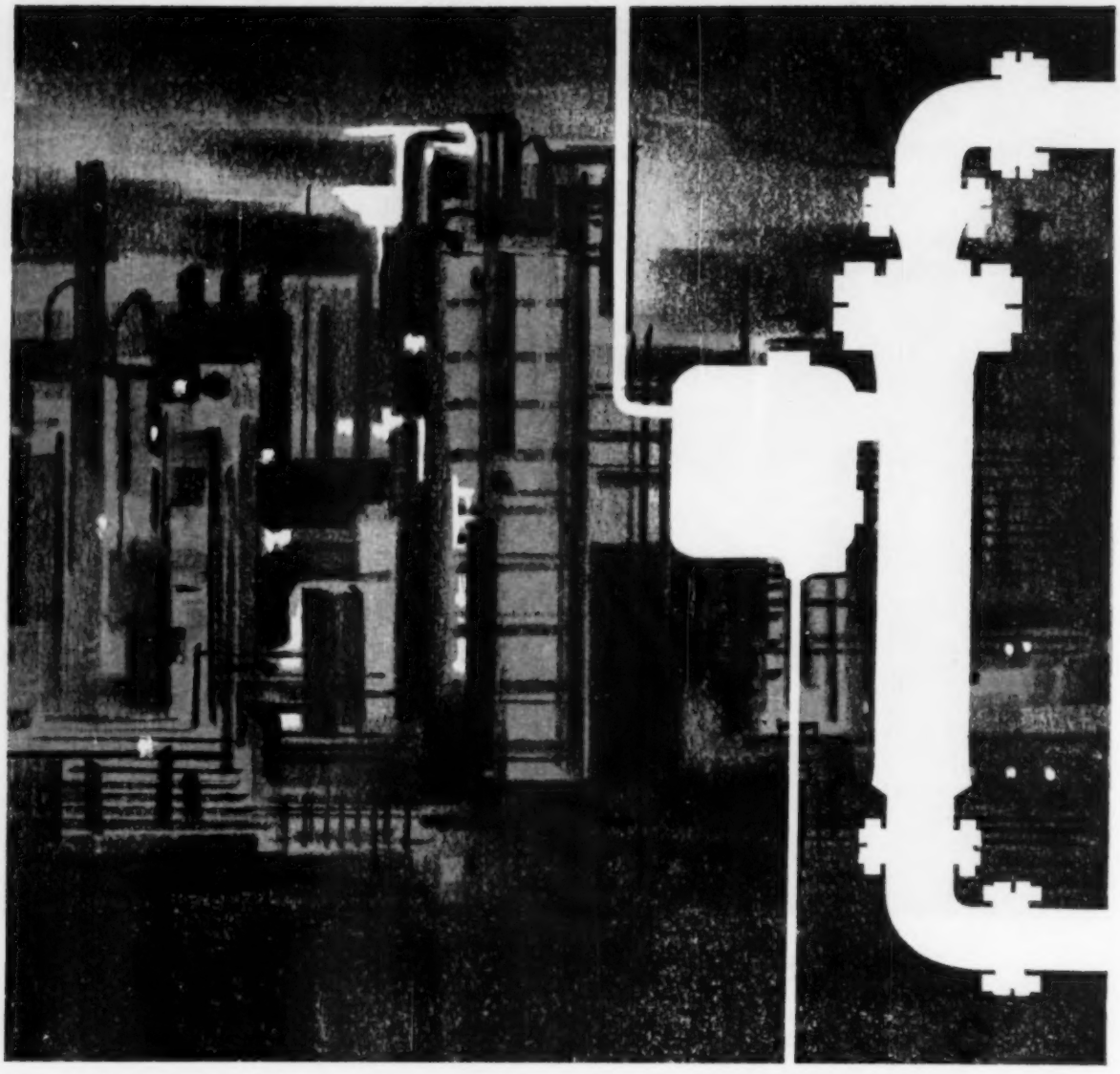

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High in sensitivity and accuracy! For full float range operation the Fisher Level-Trol is factory calibrated or zero adjusted to produce an accurate 3 to 15 psi or 6 to 30 psi signal output. Designed, engineered and universally accepted for most liquid level control, liquid level indication and interface control problems. Has simple liquid level adjustment indicating dial—combined pneumatic proportional band and specific gravity adjustment. Heavy-duty built—easy to operate—simple to service. Available with cage units for external mounting or internal top or side flange mounting with float sizes from 14″ to 120″.

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SINCE 1880

ESTABLISHMENT of a field technical sales and service office for Girdler Catalysts in Houston, Texas, is announced by the chemical products division of Chemetron Corporation. Walter H. Girdler Jr., division president, said the new offices would be located at 4007 Bellaire Blvd. and would be under the direction of Merle R. Likins, formerly a member of the Girdler Catalysts technical service staff in Louisville, Kentucky.

FORGING OPERATIONS are underway in the new plant of Gardner-Denver Company. Production was begun in the plant less than 9 months after groundbreaking. Heart of the new plant is a 36,000 sq ft prefabricated steel building housing a new forge and trim press unit and three smaller forges moved from the Gardner-Denver plant at 39th Avenue and Williams Street. This building also holds the die sink department and die and bar stock storage. Building dimensions are 150 by 240 ft.

A GROUP of 23 executives and industrialists from Sweden, Denmark, and Finland, toured the Crane Packing Company plant at Morton Grove, Illinois, in October. The team, traveling under the auspices of the Royal Swedish Academy of Industry and Science, was originated by the Swedish Association of Metal Industry. The purpose of the inspection was to get first hand knowledge of new trends and developments in management techniques in the U. S. with emphasis on production management.

ALLIS-CHALMERS MANUFACTURING COMPANY has completed construction of new engineering, development and research facilities in Greendale, Wisconsin, a Milwaukee suburb, about two miles south of the company's West Allis Works. An initial group of approximately 100 scientists, engineers, draftsmen, technicians and administrative personnel have moved into the new laboratories. When in full operation, the Greendale laboratories will employ upward to 200 persons.

THE OPENING of the 9th branch warehouse of the Norvell-Wilder Supply Company of Beaumont, Texas, was announced recently. The new branch is located at Monahans, Texas, some 40 miles southwest of Odessa. New sales offices have been recently opened in New Orleans and Baton Rouge, Louisiana.

PUFFER-SWEIVEN Company, southern Texas sales representative for Fisher Governor Company, Marshalltown, Iowa, has added a sales office in Beaumont, Texas, with Joe Meek in charge.

▸ **Charles Zartman,** who has been serving both as chief engineer and assistant to the president, will devote full time to the position of assistant to the president, Rector Well Equipment Co., Inc. Replacing Zartman as chief engineer is **George Garrett,** who was formerly development engineer of the firm. **John L. Curry** was named to the newly created position of sales coordinator. He formerly was sales manager of the cementing equipment division.

▸ **Robert M. Glover,** assistant sales manager of the Du Pont Company's petroleum chemicals division, was named manager of the newly-created sales program section of the division, while **Wilfred E. Bettoney** was designated additives sales manager. In other changes **Richard O. Braendle** took over Bettoney's duties as technical manager in the Eastern region office and **Charles B. Miller** assumed Braendle's position as technical manager in the Mid-Continent region office at Tulsa. **Joseph J. Mikita,** both additives sales manager and technical manager for the division, will devote full time to management of the technical section, including direction of the division's petroleum laboratory.

▸ **R. D. Ford** was named president of Schlumberger Surenco, S. A. Ford, as chief of the Schlumberger company which operates in South America, will continue to maintain headquarters in Caracas, Venezuela. Until his recent promotion, he was executive vice president of Schlumberger, having held that position since 1952.

▸ **Phillip G. Jackson** has joined Rector Well Equipment Company, Inc., as sales engineer in the Rocky Mountain area. Jackson will maintain headquarters for Rector, manufacturer of high and low pressure well head equipment and cementing tools, in Casper.

▸ **Ernest L. Pierce Jr.,** formerly erection supervisor for Koehring Southern at Chattanooga, Tennessee, was promoted to service manager. He succeeds Charles Lewis who recently passed away.

▸ **Charles R. "Dick" Hatcher** is named supervisor of the steel pipe pricing section of the sales department, Lone Star Steel Company. **Sonny Ogden** was appointed supervisor of the steel pipe order section.

▸ **Page Edmunds** was appointed general manager of chemicals in the W. R. Grace & Co., Davison Chemical Division. Concurrently, Edmunds has been named vice-president of Davison Chemical Company Ltd., the Canadian affiliate of the division. Formerly he was general sales manager, petroleum chemicals.

▸ **George D. Doremus,** who joined George E. Failing Company of Enid, Oklahoma, earlier this year as works manager, was elected vice president in charge of manufacturing. The Failing Company is a subsidiary of Westinghouse Air Brake Company.

▸ **H. B. (Pat) Hurley,** for many years an executive with Continental Oil Company and more recently senior vice president of Republic Natural Gas Company in Dallas, has now joined Welex, Inc. as assistant to the president.

▸ **George F. Kline** was named manager of the petroleum and petrochemicals department of Blaw-Knox Company, chemical plants division. His responsibilities will include sales, proposals, contracts, processes, and plant design.

▸ **Philip A. Roth** was elected to the board of directors of U. S. Industries, Inc. Roth is chairman of the executive committee, executive vice president and a director of General Industrial Enterprises, Inc. He is chairman of the executive committee, vice president and a director of Baldwin Securities Corporation.

▸ **Thomas E. Hastie** was appointed sales representative and will be responsible for Nebraska, western Iowa and the southeast part of South Dakota areas, for Wolverine Tube, division of Calumet & Hecla, Inc.

▸ **Harold E. Parsons** has been named assistant Oklahoma City division manager of The Western Company after completion of a special nine-month industrial management course at the Harvard Graduate School of Business in Cambridge, Massachusetts.

Seasons Greetings
We take time out to express our thanks and good wishes to all
MERRY CHRISTMAS and a HAPPY NEW YEAR
CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA

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NEW American®
GASCLOK Power Drive
constant high power • uniquely accurate

Actual Size

American's new ***GASCLOK*** is a completely self-contained air or gas powered instrument drive and timing unit. Supplying a constant power output of over 20 times the torque delivered by conventional spring-wound clock mechanisms, it is ideally suited as either original or replacement equipment where continuous power and accurate timing are essential.

Perfect for all circular or strip chart records from one-hour to 30-day periods. Constant power and timing accuracy are assured since there is no "mainspring" to weaken or run down. Rugged durability and dependability are built into the ***GASCLOK*** Power Drive for years of service with minimum maintenance. It can provide new metering accuracies and economies for you.

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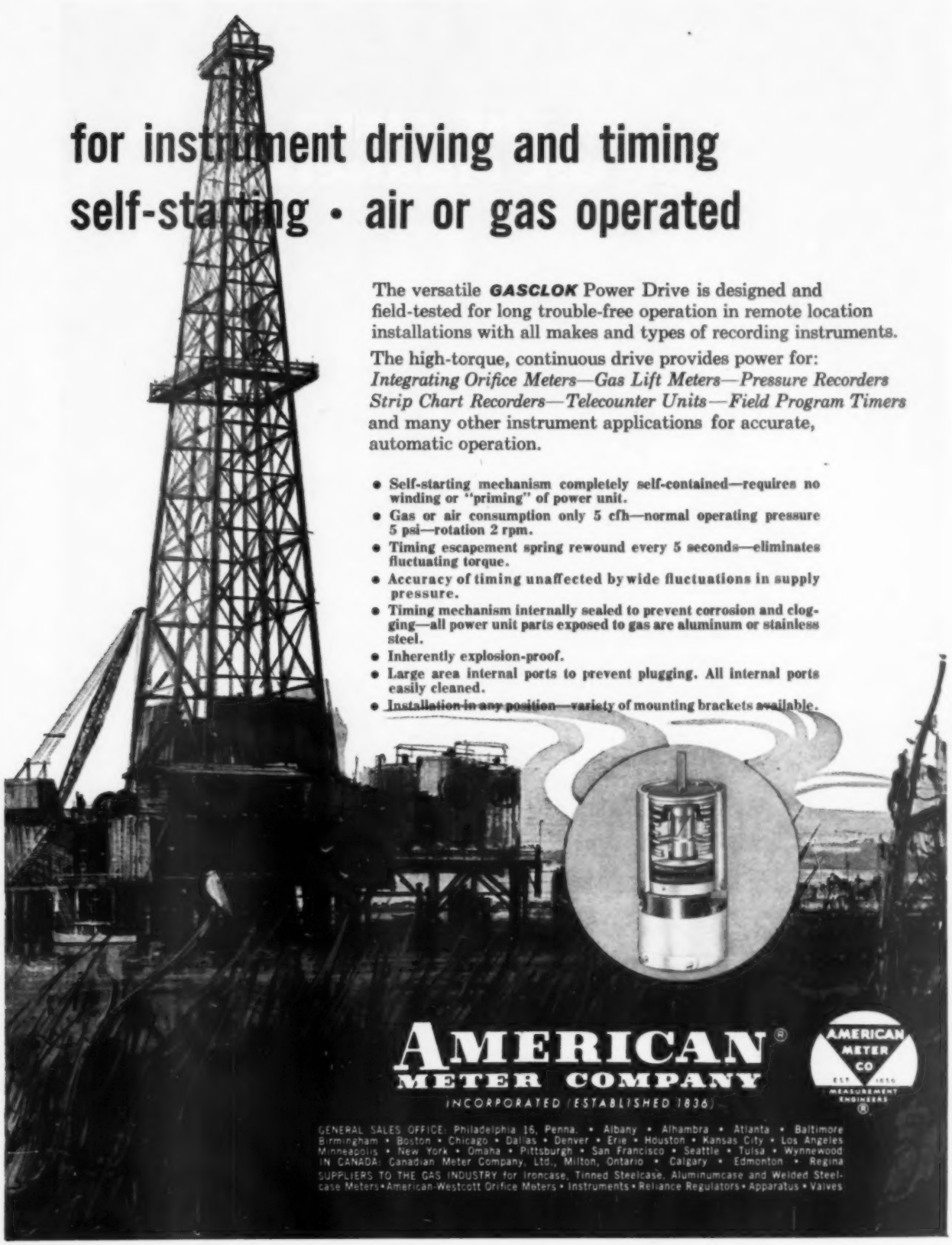

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The versatile ***GASCLOK*** Power Drive is designed and field-tested for long trouble-free operation in remote location installations with all makes and types of recording instruments.

The high-torque, continuous drive provides power for: *Integrating Orifice Meters—Gas Lift Meters—Pressure Recorders Strip Chart Recorders—Telecounter Units—Field Program Timers* and many other instrument applications for accurate, automatic operation.

- **Self-starting mechanism completely self-contained—requires no winding or "priming" of power unit.**
- **Gas or air consumption only 5 cfh—normal operating pressure 5 psi—rotation 2 rpm.**
- **Timing escapement spring rewound every 5 seconds—eliminates fluctuating torque.**
- **Accuracy of timing unaffected by wide fluctuations in supply pressure.**
- **Timing mechanism internally sealed to prevent corrosion and clogging—all power unit parts exposed to gas are aluminum or stainless steel.**
- **Inherently explosion-proof.**
- **Large area internal ports to prevent plugging. All internal ports easily cleaned.**
- **Installation in any position—variety of mounting brackets available.**

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It's TIGER BRAND of course!

This new wire rope was developed to meet the need for longer life in sand lines, swabbing lines, coring lines and cable tool drilling lines. It has a plastic impregnated fiber core which combines the good deterioration resisting properties of a plastic core with the excellent strand supporting characteristics of a fiber core.

The plastic protects the fiber and prevents absorption of acids and other hole fluids. Consequently, the rope retains its structural balance even when used in drilling or swabbing acidized or sour wells.

One of these new Fibreseal ropes was used in cleaning out 23 wells. Twelve of the wells were acidized and very corrosive. After four months of service, the rope was checked for deterioration. The core was found to be in good condition, having resisted all well fluids without trouble. The user was extremely well pleased with the extra service life he obtained, and the behavior of the line has been very satisfactory.

Send the coupon for the complete story on USS Tiger Brand Fibreseal Wire Rope.

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Trade Parade

M. W. "Cy" Reed was promoted to foreign operations manager—western hemisphere for Halliburton Oil Well Cementing Company. He was formerly in charge of Halliburton's Canadian subsidiary since 1948 and had earlier spent 7 years in foreign oil fields.

C. L. "Slim" Nelson has been appointed a Four Corners warehousing and service representative for B and W primary cementing tools. Nelson is a pioneer in oilfield services, with warehouse and yard facilities on Shiprock Highway in Farmington, New Mexico.

Glen Tableman was named manager of W-K-M Valve Company (Britain) Ltd. He was previously general sales manager of W-K-M, a division of ACF Industries, Inc.

Bart DeLorenzo and **William G. White** of the Barth Engineering Company were appointed sales representatives in California of Buflovak Equipment Division, Blaw-Knox Company.

H. Benjamin Duke Jr. was named manager of industrial relations for Gates Rubber Company. Also, **Edwin J. Busch Jr.** named divisional advertising manager for industrial products and **Warren S. Williams,** to manager of printing services.

Joe McGraw Jr. has joined Security Engineering Division (one of the Dresser Industries) as a regional sales representative. He was formerly with American Iron and Machine Works Company.

Clifford S. West was named sales representative of the Lunkenheimer Company. West will operate out of the Boston branch office.

William F. Boyd was appointed vice president of operations at Kellogg Switchboard and Supply Company, communications division of International Telephone and Telegraph Corporation. Boyd was a Kellogg vice president and formerly director of manufacturing.

In other promotions, **Douglas M. Anderson** was elevated to director of manufacturing for central office (telephone switching) equipment; **Robert A. Nieminen** named director of manufacturing for transmission and telephone, and **Richard M. Hultberg** appointed successor to **Ben E. Swanson** as manager of the electronic products division. Swanson recently was made director of the newly-formed systems engineering division.

Albert P. Gagnebin was elected a vice president and **Joseph M. Weldon** as an assistant vice president of The International Nickel Company, Inc. Gagnebin was formerly an assistant vice president. Weldon was assistant to the vice president.

Robert S. Wright was named president of USI International, a division of U. S. Industries. Prior to this appointment, Wright had been general manager of the Winchester International division of Olin Mathieson Company for the past seven years.

John R. Smith, formerly corrosion engineer for Dowell, has joined Tretolite Company, division of Petroleum Corporation, in the same capacity in the South Louisiana district. **Ed L. Dressel,** head of the company's field service laboratory at Odessa, Texas, was transferred to the sales department as a corrosion engineer for the west central division. He will replace **Mike C. Deodati Jr.,** who was transferred to the southern division at Houston. **Robert W. Taylor,** a technician in the St. Louis, Missouri, laboratory, has been named junior testing engineer and will replace Dressel at Odessa.

Donald F. Wishart, who has been chief project engineer of the chemical division of Stone & Webster Engineering Corporation in Boston, was named engineering manager of Stone & Webster Engineering N.V., recently formed subsidiary in the Netherlands.

Charles Clark, 3rd generation descendant of the original founders, was named sales-engineer for the Clark Bros. Co., Pittsburgh offices. He formerly served six years with Bradbury Kenrick Associates, manufacturer's agents for Clark Bros. in Detroit.

A new Denver branch office of Clark Bros. has been opened. **Jay B. Williams** was named manager.

George L. O'Connor was named to a newly created post for the promotion and sale of gas turbines in the eastern half of the U. S. for Clark Bros.

Hoyt Stout was named regional sales manager in New Jersey, Delaware, and southeastern Pennsylvania for Motorola Communications & Electronics, Inc. Stout has sales responsibility for Motorola's mobile, portable and special two-way radio products in the region. He succeeds **Wallace Miller,** who is now the New York state manager.

Walter M. Northey has been appointed general superintendent of Gulf States Tube Corporation, Rosenberg, Texas, a wholly-owned subsidiary of Michigan Seamless Tube Company.

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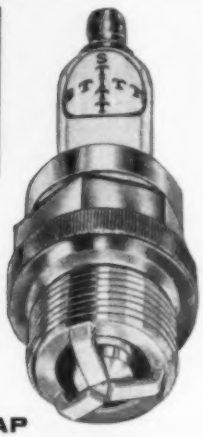

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Trade Parade

▸ **C. Ross Spencer** is named vice president and manager, foreign marketing, and **Charles T. Jones** is the new vice president and sales manager, Oil Center Tool Company. Spencer formerly was sales manager, Jones was assistant sales manager. New regional sales managers are **M. E. (Mike) Hunter,** for the eastern region, and **A. C. (Bus) West Jr.,** for the western region. All will have headquarters offices in Houston, Texas.

▸ **Louis J. Prior** was appointed traffic manager, machinery division, and **William T. Hoffman** traffic manager, tubular division, by The National Supply Company. In their new positions, these men will divide the responsibilities formerly held by **John N. Lind** as general traffic manager. Lind recently was named director of transportation for Armco Steel Corporation, of which National Supply is a subsidiary.

Two members of National Supply's headquarters organization in Pittsburgh were appointed to supervise the design, construction, and operation of the company's exhibit at the International Petroleum Exposition, Tulsa, May 14 to 23. **H. E. Heywood Jr.,** appointed exhibit manager, and **William C. Marmack** assistant exhibit manager.

▸ **Paul J. Louzecky** was appointed chief engineer, engine division Nordberg Manufacturing Company, Milwaukee, Wisconsin. Prior to joining Nordberg, Louzecky was chief technical engineer for the Cleveland diesel engine division of General Motors Corporation.

▸ **Don Witherspoon Jr.** was appointed representative at Odessa, Texas, by Macco Sales & Service.

▸ **William A. Pratz** was appointed manager of the Victoria, Texas, store of U. S. Steel's Oil Well Supply Division. The transfer of **L. Hamilton Shaw,** assistant district engineer at Farmington, New Mexico, to Fort Morgan, Colorado, was announced, also.

New field representatives for "Oilwell" are: **Herman L. Temple** as field representative at Pettus, Texas; **John Rice** to the Valleyview, Alberta, Canada, store; **D. H. Schoonover** as field representative at Hobbs, New Mexico, and the transfer of **Dean L. Cook,** field representative at Pettus, to McAllen, Texas.

▸ **William S. Aiken** has been named manager of the project engineering department, engineering division, The Thompson-Ramo-Wooldridge Products Company, and acting manager of the division's programming department. The project engineering department handles the installation and check-out of computer control and data logging systems.

Dr. Thomas M. Stout has been named manager of the process applications department, engineering division. This department conducts joint applications studies with petroleum refining, chemical, and other companies in the process industries to plan computer control systems for selected processes. **Charles G. Laspe** has been named associate manager of the process applications department.

▸ **William M. Freeman** was named manager of Chicago Bridge & Iron Company's process equipment sales group, headquartered in New York.

Antonio Nelson de Abreu Cervone has been made a sales representative by Chicago Bridge Construcoes, Ltda., Brazilian subsidiary of Chicago Bridge & Iron.

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Hardness differential between seats	●	●				●	
Cold-rolled female seat	●					●	
45° cone-to-ball seat	●	●	●	●		●	
Cadmium-plated nut	●		●			●	
Ends taper-reamed before threading	●		●		●	●	
Published steel specifications	●				●		
Each union individually tested	●						
Induction-heated for forging	●						
Hot-forged	●		●	●	●	●	●
Octagon wrench flats on ends	●		●	●	●	●	
Octagon wrench flats on nut	●	●	●	●	●	●	
Rounded nut and end wrench flats	●		●		●	●	
Turbulence-free fit across seats	●		●	●		●	●
Machined surfaces finished to "#40 turn" or finer	●	●			●		●
All sharp corners relieved	●	●					

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A REAL PIPE SEALER
Pressure held 20,000 psi up Liquid or Gas
U.L. approved for butane, propane, gasoline, petroleum.
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NO HEAT FREEZE
Temperature range—100° to 2987° F.
NO CORROSION WELD
Stops rusting, acid-etch and corrosion.
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Recommended for aluminum, stainless, titanium, plastic, steel, brass, etc.
EASY DISASSEMBLY ANYTIME
Better than new threads.

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Harry E. Paulsen, General Manager
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DETROIT

Trade Parade

▸ **Phil S. Hurst** was promoted to assistant product manager, gas engine compressor sales, The Cooper-Bessemer Corporation. In his new capacity, Hurst will assist **Don Reed,** product manager.

William J. Burkstaller and **Gilbreth D. Adams** were appointed to the Cooper-Bessmer New Orleans field office. **Freeman A. Gehres** was named branch office manager in New Orleans.

Sven T. G. Swanberg was assigned to the Cooper-Bessemer New York field office. He will assist in engineering and sales relative to the application of centrifugal and reciprocating compressors for chemical and processing industries and will work under the immediate direction of **C. J. Havekotte,** New York branch manager.

▸ **Don V. Stone** was appointed manager of the Kelley ripper division of Crutcher-Rolfs-Cummings. Prior to his appointment, Stone served in sales work for Caterpillar Tractor Company for 19 years, and with Euclid Division of GMC for two years.

▸ **H. M. Shearin** was appointed assistant manager in charge of domestic studies, and **W. P. Schultz** named assistant manager in charge of foreign studies, Core Laboratories, Inc.

▸ **C. L. Brain** and **W. F. Hays** were transferred from Borger, Texas; **S. S. Middleton** from Jacksonville, Florida; **G. W. Nairn** from Great Bend; and **Paul Swift** from Tulsa, to Sterling, Colorado, due to increased field activity for Dowell.

Further strengthening of the company's sales organization in the Rocky Mountain states was accomplished by the transfer of **Warren Sallee** from New Orleans to the district office in Denver.

▸ **August Nuut** was appointed principal engineer, transistor circuitry, DataTape division, Consolidated Electrodynamics Corporation. He was formerly a project engineer with Ralph M. Parsons; senior project engineer, Hycon Manufacturing; project engineer, West Coast Electronic; and research engineer, Northrop Aircraft.

▸ **V. R. Hershberger** was appointed sales representative for the C. Lee Cook Company for all of Eastern Ohio. He has been in the field of sales engineering for the past seven years, and most of this experience has been in mechanical packings.

▸ **J. T. (Jack) Teed** has been appointed by Brown Instruments Division of Minneapolis-Honeywell Regulator Company as market manager for petroleum industry instrumentation. He formerly served as industrial sales manager in Tulsa and as eastern sales supervisor, systems engineering.

▸ **Jack M. Slough** and **James G. DeFlon** have formed the new cooling tower engineering firm, Slough-DeFlon. The firm will maintain headquarters in San Marino, California, with agents in strategic areas throughout the country.

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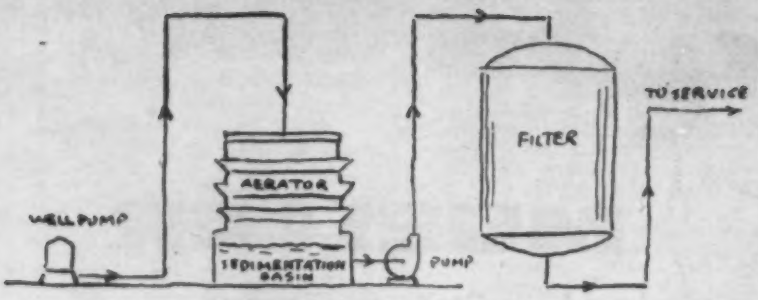

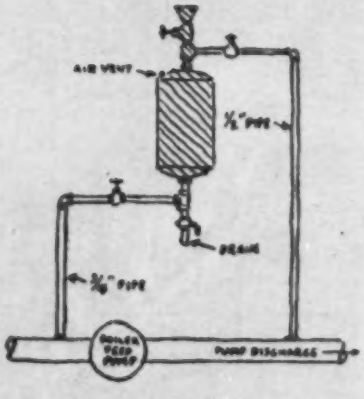

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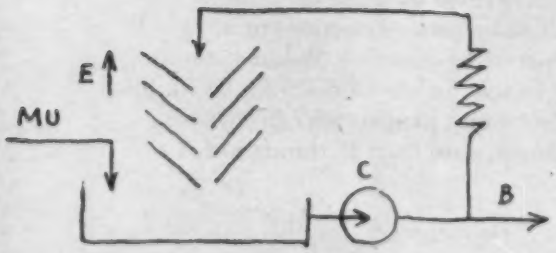

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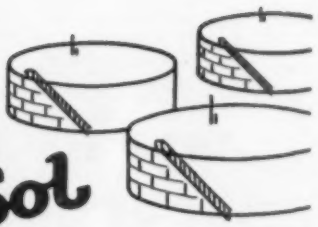

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...because it was a better pipe wrench when first created 35 years ago, and has been improved nearly every year since . . . in performance, design, materials. Today, it is still the most for your money. Buy RIDGID at your Supply House.

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Books to Read

Oil and Petroleum Year Book, *1958, compiled and published by Walter E. Skinner, 20 Copthall Avenue, London, E.C.2., England. Pages, 799. Price, $7 (Post Free).*

Mr. Skinner's compilation, in its 49th edition, gives complete and up-to-date particulars of 1070 of the principal British, American, Canadian, and foreign oil companies, operating in all parts of the world, and covering all branches of the industry. A list is also included of 730 names and addresses of managers, engineers, etc., and the companies in the book with which they are connected.

Two tables also are included. One shows the world's oil production and contribution which individual countries have made for each of the last 10 years. The other indicates international oil companies operating in the Middle East. The author also has provided colored maps in the contents: "Trans-Canada Natural Gas Transmission System"; and "Middle-East Oilfields, Refineries, Pumping Stations, and Pipelines".

A "Buyer's Guide" section comprises 1000 headings of manufacturers of plant, equipment and accessories.

The Federal Basis for Weights and Measures, *A Historical Review of Federal Legislative Effort, Statutes, and Administrative Action in the Field of Weights and Measures in the United States, by Ralph W. Smith, National Bureau of Standards Circular 593. Pages, 23. Price $0.30. (Order from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.)*

This attractively illustrated circular presents a chronological review of Federal legislation and congressional efforts in the general area of weights and measures for the period 1776 to 1956, with particular emphasis on units and standards. It combines information previously available only from scattered sources, and will be useful to weights and measures officials, and researchers in the practical functioning of government.

Certain important and closely related administrative actions initiated by Hassler and Mendenhall in the 19th century are cited. The publication consists of three parts, covering the Hassler Era, to 1836; the Mendenhall Era, 1836-1896; and the Modern Era. Current Federal statutes having weights and measures significance are discussed briefly.

Dynamic Decade, *by Eric J. Hanson. Published by McClelland & Stewart Ltd.; distributed by Dodd Mead & Company, Inc., 432 Fourth Avenue, New York 16, New York. Pages, 314. Price $6.*

The oil discovery at Leduc, Alberta, ushered in a new era for Canada. This book combines cold statistics and local color surrounding the phenomenal growth of the oil industry in the province, with an appealing and lucid chronology as the net result. The text will make fascinating reading, and provide an invaluable reference on all phases of the Canadian oil industry.

Well Logging, *published by Society of Petroleum Engineers of AIME, 800 Fidelity Union Building, Dallas 1, Texas. Pages, 168. Price, $2.50.*

Logging engineers and geologists will find this new book of particular interest, since it combines a large number of selected papers from *Petroleum Transactions* covering electric logging interpretation and devices, gamma-ray-neutron logging and dipmeter logging. A bibliography of all papers on well logging, appearing in *Transactions* in past years, has been included.

The book is the first in a proposed series of volumes dealing with specific areas of the petroleum industry.

A Century of Texas Oil, 1875-1975, *proceedings of the Eleventh Oil Recovery Conference in Austin, Texas, published by Texas Petroleum Research Committee, Room 201, P.E.B., The University of Texas, Austin 12, Texas. Pages, 262. Price, $1.*

This paper-bound volume contains 22 addresses and technical papers reviewing the Texas oil industry in the past 75 years and forecasts the coming 25 years. Most of the volume is devoted to technical papers and engineering analyses, and includes a historical review, reports on new oil recovery methods, and even some information on the possible and probable use of electronic and nuclear energy in the production of oil. All papers are complete with accompanying illustration, charts, graphs and data tabulations.

Operations Research Reconsidered. *Management Report No. 10, published by American Management Association, Inc., 1515 Broadway, Times Square, New York 36, New York. Pages, 143. Price, $3.75 (AMA members, $2.50).*

Is operations research useful and practical as a management tool? In this report, both OR practitioners and operating executives present a wide range of opinions — supported by their own experience — on these important questions. To indicate just how extensively the new techniques are actually being used, the report includes a detailed survey of industrial OR programs and practices in the United States.

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Laugh with Barney

Two cockroaches lunched in a dirty sewer, and excitedly discussed the spotless glistening new restaurant in the next block.

"I hear," said one, "that the refrigerators shine like polished silver. The floor sparkles like diamonds. It's so clean."

"Please," said the second cockroach in disgust, "not while I'm eating!"

* * *

"For goodness sake, use both hands!"

"Can't. Gotta drive with one."

* * *

We have it on good authority that the addition of a glass of beer often improves the flavor of a pinch of salt.

* * *

Employer: Myrtle, who told you that you could neglect your office just because I give you a kiss now and then?

Stenographer: My attorney.

* * *

"What has more fun than people?"

"Rabbits."

"Why?"

"Because there are more rabbits than people."

"Why?"

"Because rabbits have more fun than people."

* * *

A bigamist is a man who has taken one too many.

* * *

A fellow told me the other day that he was so unlucky that if Lady Godiva was riding side-saddle down Main Street he would be unlucky enough to be standing on the wrong side of the street.

* * *

The absent-minded professor and his absent-minded wife were spending a quiet evening at home when someone banged on the door. She yelled, "O Gosh, my husband!" And he jumped through the window.

* * *

A stingy husband, while out of town, sent his wife as a present a check for a million kisses. The wife, a little annoyed, sent back a post card: "Dear Jim, thanks for the birthday check. The milkman cashed it for me this morning."

* * *

Prosecuting attorney: "You mean to say you had 16 beers and didn't move once from the table the night of the murder?"

* * *

Jones, a good family man, had been inveigled into a poker game, and experienced growing apprehension as the hand of the clock moved relentlessly on toward morning. Finally, at 3 a.m., he had a sudden inspiration. He called his home, and when his wife answered the phone, he shouted, "Don't pay the ransom; I'm back."

A newlywed wired his boss: "Please extend my vacation. It's wonderful here." To which the boss replied: "Come back at once; it's wonderful any place."

* * *

A man about to be electrocuted phoned his lawyer from the death chamber. "They are about to put me in the electric chair," he said. "You are my lawyer — what can I do now?" The lawyer answered helpfully, "Don't sit down."

"Of course, you'll stick to the job of marrying off your daughters."

"Yes, 'til the last gun is fired."

* * *

Mazie: "I know that fellow awfully well. In fact, we've broken bread together."

Fanny: "Heck, I know him even better than that. We've broken a couple of davenports together."

* * *

Said the movie director to the cameraman, "Don't shoot until you see the whites of their thighs."

* * *

Cooperation would solve most of our problems. Freckles would be a nice coat of tan if they'd get together.

WHEELING

COUPLINGS

FOR OIL COUNTRY USE

LINE PIPE COUPLINGS — 1/8" to 12" — Seamless — Black or Galvanized

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STEEL BUSHINGS AND PLUGS — 3000 Lb.

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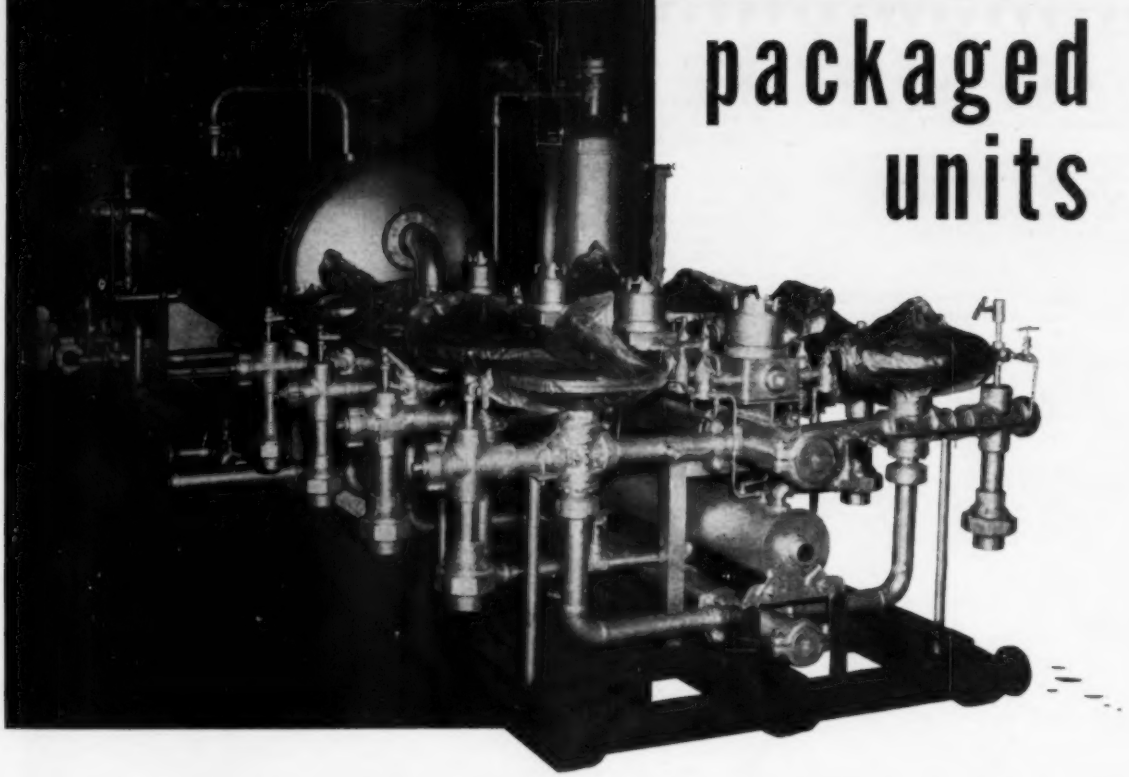
NATIONAL® automatic packaged units

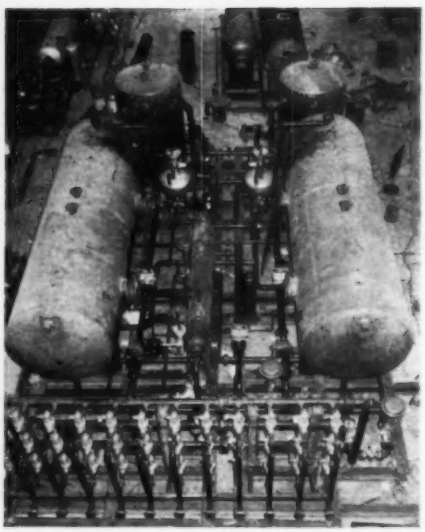


WHY BUY NATIONAL PACKAGED PRODUCTION EQUIPMENT UNITS . . .

- **Made in shops having the most complete and modern facilities available**
- **Safe-tested under strictest codes**
- **Properly engineered for accessibility**
- **Lower cost due to National know-how**

National Packaged Units assure delivery at the location of COMPLETE units . . . skidding, piping, insulation, instrumentation, coatings and accessories. "Packaging" by National eliminates the purchase and assembly of hundreds of items; eliminates costly waiting time and transportation charges rounding up missing materials and fittings.

Through good engineering, design and arrangement, the connection crew in the field is concerned only with the major product lines to and from NATIONAL PACKAGED UNITS.



National can handle all your production problems "from the wellhead to the consumer."

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Modern facilities include sand blasting and coating.

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With Field Engineered Units TODAY BACKED BY Parts and Service Tomorrow!

- Cabot quality pumping units with field proven low maintenance.
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- Parts and 24 hour service thru Cabot-Franks Service Depots.
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Beam balanced units 3,000 to 11,000 lbs. capacity.
Adjustable crank units 7,000 to 32,000 lbs. capacity.
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Sub-Surface Protection
Against Wild, Uncontrolled Flow

OTIS TUBING SAFETY VALVES

Otis Tubing Safety Valves, set by Otis crews, have never failed to shut in a blow-out. To assure you of maximum protection, Otis Tubing Safety Valves should be pulled regularly for inspection and the setting checked against current well conditions. Don't assume safety — find out and make sure your wells are protected by Otis Tubing Safety Valves!

Play it safe with a safety program — call Otis

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Otis - "Everything's Under Control"

Of Things To Come . . . In Oil

ANOTHER AIR/GAS DRILLING TOOL will be put on the market soon. Look for an inflatable-type drill collar squeeze packer, now in final experimental stages, to be successfully field tested before the end of the year. The tool permits squeezing of water-bearing formations to effect a shutoff quickly after the encounter and without necessitating a trip out of the hole. Packer would be run very close to the bit, and when perfected, the 6¾-in. OD tool would permit drilling, squeezing, drilling and squeezing again without coming out of the hole.

INCREASED DEMAND FOR CRUDE during December and into next year is seen by IPAA and API forecasters. IPAA thinks it probable "That petroleum demand during the fourth quarter this year could average 10,000,000 bbl per day. And in the first quarter of 1959, it could easily average 10,500,000 bbl a day. A combination of abnormally cold weather and accelerated economic recovery could push these averages higher . . . December this year could see a demand which averages 2,000,000 bbl a day higher than the September rate." Total demand for that month was 8,785,000 bbl a day.

SLIM HOLES FOR ULTRA DEEP WELLS is more feasible today as a result of improved metallurgy and modern techniques than many drilling people realize. The feasibility of slim holes for ultra deep wells was proved in Ginther-Warren and Company's No. 1-A Killiam dry hole recently plugged at 19,500 ft. This wildcat well, located near Laredo, Texas, drilled a 4 11/16-in. hole through 5½-in. liner bottomed at 16,500 ft. This 3000-ft interval was drilled with a diamond bit and a special surfactant mud with no difficulty.

TUBINGLESS COMPLETIONS INCREASING in U. S. as well as Canada. New idea utilizes slim hole in which tubing is cemented. Method is feasible by virtue of revolutionary new tools, services, and equipment now available throughout the oil patch. Only recently, a triple string of tubing was cemented inside a well in the Gulf Coast area. This well was not equipped with casing. It is industry's engineered approach to reduced drilling and well completion costs, and you can look for it to advance rapidly.

FOURTH-QUARTER DRILLING WILL BE UP "CONSIDERABLY" above the year's average, predicts E. B. Germany, president of Lone Star Steel Company. The Texas-based manufacturer of oil country tubular goods is a gage of Southwestern oil activity, in that its operations fluctuate with drilling volume. The company has placed back in operation three open hearth furnaces to replenish inventories of various size casing; it has shut down intermittently in past months in line with drilling slumps.

THREE ROILINE ENGINES

drilling

World's Deepest Well

...23,450 ft. and still going

ROILINE ENGINES

Phillips Petroleum Co. Rig No. 27, in Pecos County, Texas, has three ROILINE Engines

In Pecos County, Texas, Phillips Petroleum Co. Rig No. 27 is drilling the world's deepest oil well—with three L-4000 ROILINE Gas Engines.

Designed for deep hole drilling, these modern, compact gas engines have the additional power, with fast response to load demand, that makes more hole. They do it with less fuel; and maintenance is easier, too.

With their 12 cylinders in V-type arrangement, Model L-4000 ROILINES are basic valve-in-head engines of 4000 cu. in. displacement, 7.54 bore x 7.5 inch stroke, operating on gas fuel. Hydraulic "Zero Lash" valve lifters eliminate tappet noise and adjustments and extend valve life. Exhaust manifold is water cooled and integrally cast into crankcase to provide cooler operating area and fast warm-up of the engine. Removable wet cylinder sleeves; counterweighted crankshaft and precision bearings; full flow oil filters and many other ROILINE features are all fully described in Bulletin E-7.

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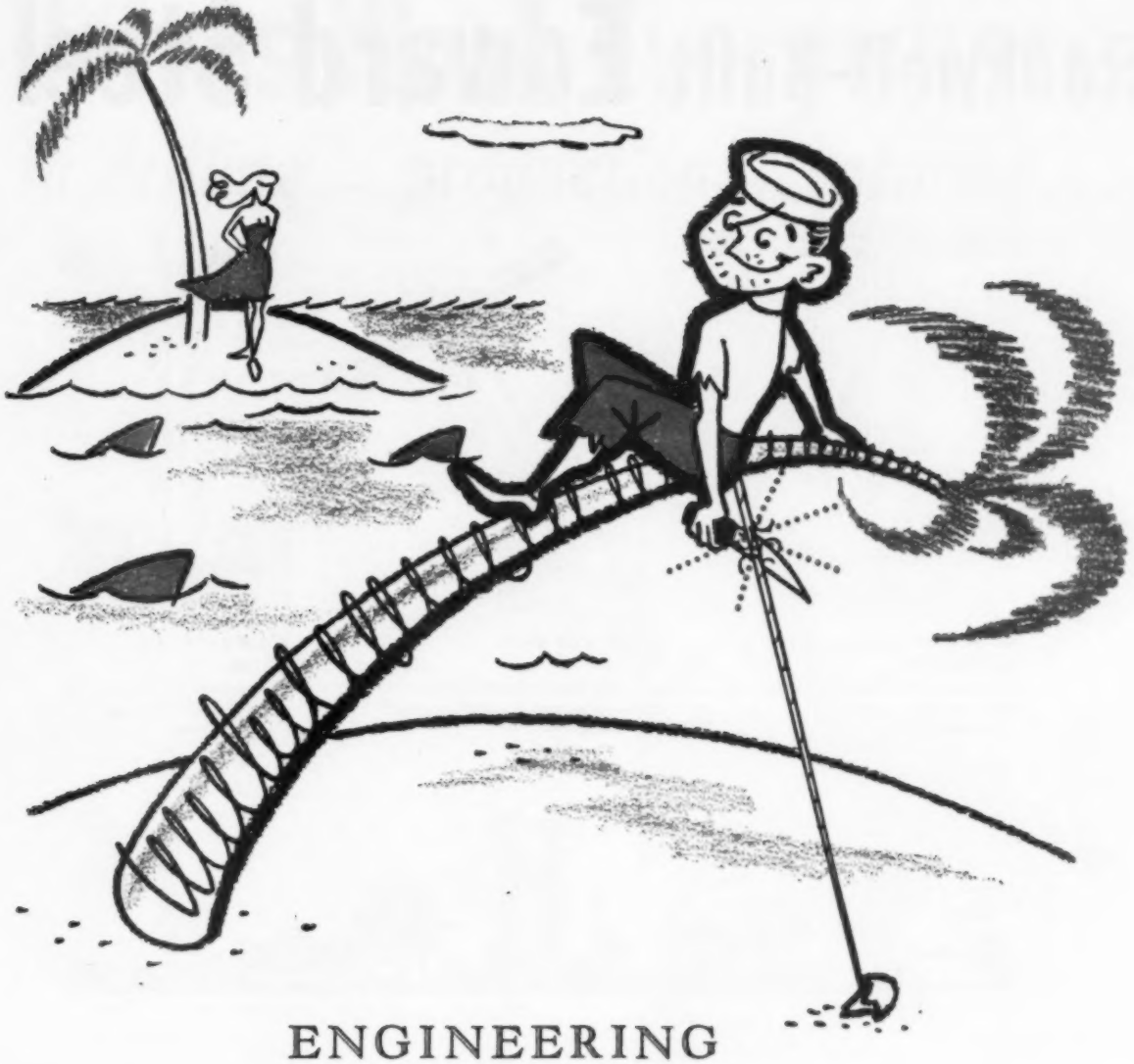

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The best solution to any problem is based on experience. The Parkersburg Rig & Reel Company, pioneers in oil and gas handling equipment, is staffed with engineers who are experienced in solving all types of production processing problems. For the most economical answer to your oil and gas handling problem, look to Parkersburg's engineering know-how for the answer.

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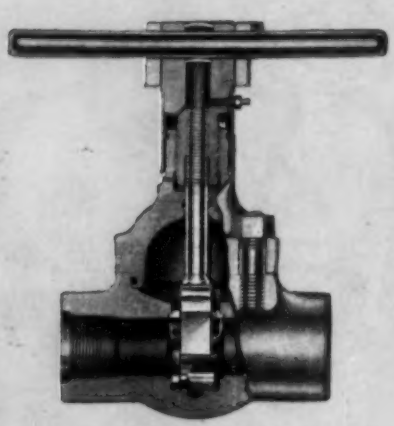
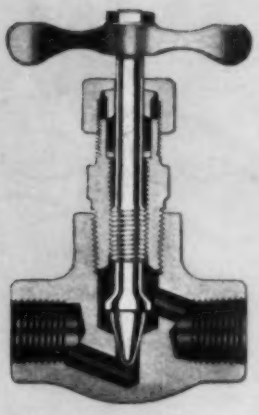
Rockwell-Built Edward Steel

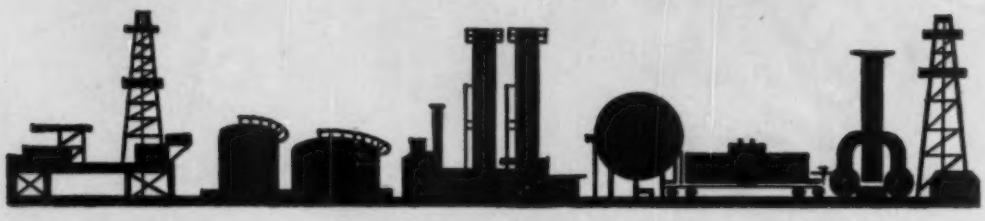


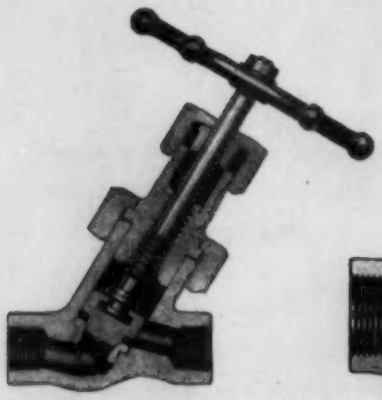
MUDWONDER MUDLINE VALVES
Figs. 2128-3128
For pressures to 2,000-3,000 lb WOG
Bolted bonnets, screwed or flanged ends

GLOBE STOP VALVE
Fig. 158
For pressures to 10,000 lb WOG
Screwed bonnet, screwed or socket welding ends

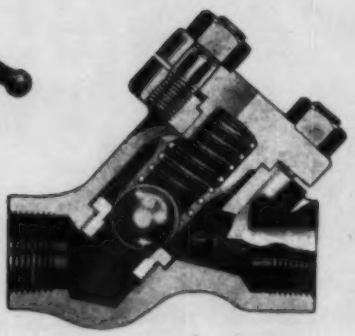


GLOBE GAGE VALVE
Fig. 152
For pressures to 4,000 lb WOG
Screwed or union bonnet, screwed ends

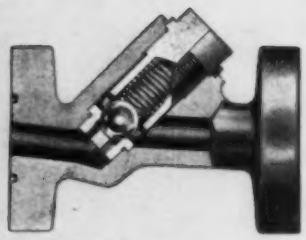




GLOBE STOP VALVE
Fig. 2698
For pressures to 2,000 lb WOG
Union bonnet, screwed or socket welding ends



BALL CHECK VALVE
Fig. 4632
For steam pressures to 600 lb A.S.A. (2,000 lb WOG)
Horizontal or vertical
Bolted cover, screwed or socket welding ends



BALL CHECK VALVES
Figs. 5160-9160
For pressures to 5,000-10,000 lb WOG
Horizontal or vertical, screwed covers, flanged ends

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Edward valves are on the job, no matter where you look. From the towering derricks of Northern Alberta to offshore rigs on the Gulf . . . from refineries on the Jersey Flats to California natural gas plants . . . the word is—"You buy a better valve from Edward!"

Edward Globe Valves

Bodies are drop-forged steel, for greater strength and resistance to erosion. Large-diameter handwheels permit operation without a wrench or cheater; cross-arm Impactor* handle for quick, tight closing is standard on 2" Fig. 158. Figures 158 and 2698 have replaceable seats. Disks—both plug and needle types—are carefully aligned, and seats are lapped for tight sealing. Stems are EValloy,* an exclusive Edward stainless steel, centerless ground to a fine finish. Carefully machined Acme stem threads assure easy operation. Bonnet threads plated by an exclusive EValizing* process for maximum resistance to wear and corrosion. Deep stuffing boxes, with exclusive EValpak* asbestos-graphite packing, assure a tight seal with minimum resistance to stem turning.

Edward Ball Check Valves

Identical to Edward globe stop valves in body and seat features. Rolled steel bonnet with integral ribs to guide ball accurately. Ball is corrosion-resistant high carbon stainless steel, precision-ground for tight seating. High carbon stainless steel spring gives positive aid in seating ball.

Edward Mudwonder Valves

Body and bonnet are high-strength alloy steel with heavy body-bonnet cover flanges. Accurately machined to assure drop-tight sealing under extreme pressures. Double-threaded yoke bushing, completely enclosed, gives 2-to-1 ratio. Corrosion-resistant stainless steel stem with slotted gate coupling to eliminate bending or binding. Gate is hard chrome plated to reduce friction, resist erosion and abrasion. Seat insert of resilient buna–N synthetic rubber, molded integrally over steel wear rings. Seat and gate easily replaced without removing Mudwonder* from line.

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Our customers report complete satisfaction in the use of Edward valves for water flood service . . . throttling . . . on high-pressure heaters, treaters and separators . . . on pressure vessel controls . . . on headers and flow lines to heaters and exchangers . . . for manifold service . . . in gasoline or gas sulfur extraction plants . . . for "unloading" valves at gas compressor stations . . . and in many other applications. You name your need . . . let your Edward representative show how to fulfill it with versatile, economical, completely dependable Edward valves. They are available from your favorite oil field supply store, from your industrial distributor, or direct from *Edward Valves, Inc., 1220 W. 145th Street, East Chicago, Indiana* (Subsidiary of Rockwell Manufacturing Company). Represented in Canada by Lytle Engineering Specialties, Ltd., Montreal, and Rotary Sales & Service, Ltd., Edmonton.

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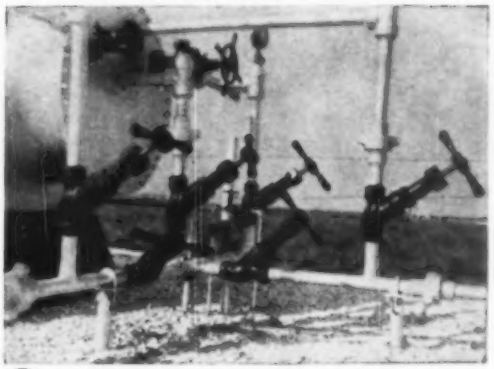

Edward 2" Fig. 158 valves in service on heater by-pass lines in Louisiana oil fields. Note Impactor handles for quick, easy closing against high pressures.

Fig. 2698 valves on cooling coils of natural gas cooler. Scene: New Mexico field processing plant. Lubricated plug valves in photo are Rockwell-Nordstrom.

Forty-two Edward forged steel globe valves (Fig. 2698) throttle the flow on this West Texas water flood. Owner reports absolutely no maintenance costs in two years (over 4,000,000 barrels of water)!

YOUR DRILLING DOLLARS GO FURTHER WITH

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These six models meet all conditions from light portable rigs to high-pressure deep well drilling:

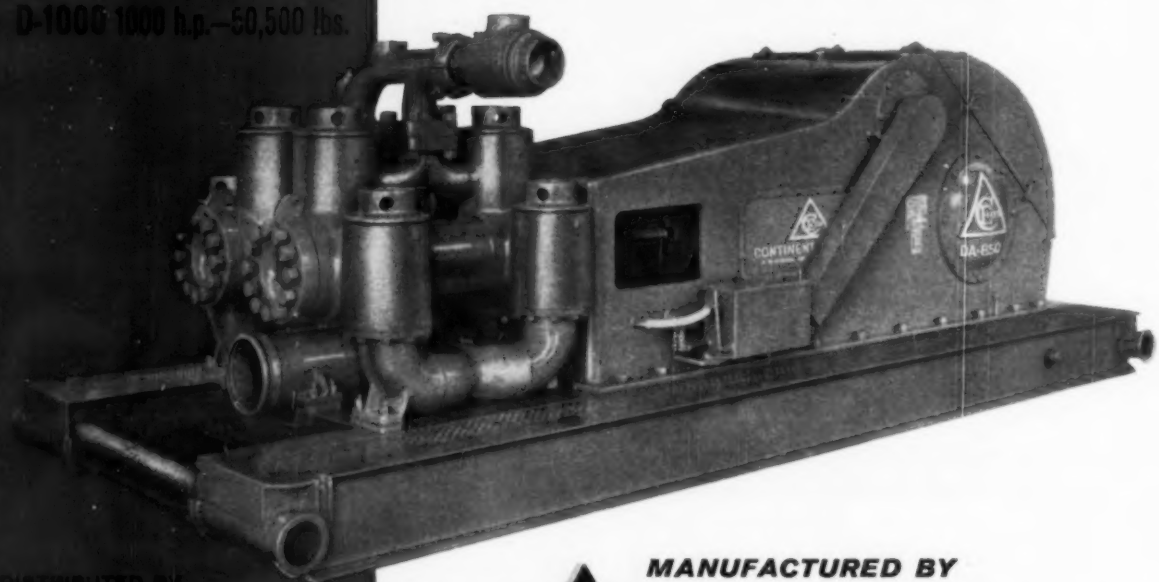
D-175 175 h.p.—10,700 lbs.
D-300 300 h.p.—16,900 lbs.
DA-500 500 h.p.—28,000 lbs.
D-700 700 h.p.—37,500 lbs.
DA-850 850 h.p.—49,090 lbs.
D-1000 1000 h.p.—50,500 lbs.

No *wasted* dollars here. Low weight of these pumps cuts transportation costs . . makes them easier to handle around the rig for faster spudding-in. Lightweight steel plate construction replaces bulky, heavy castings.

Maintenance downtime is greatly reduced. Daily adjustments are not necessary. Lubrication is completely automatic, and greasing is not required. Patented "exposed" liner design helps prevent liner washouts, since packing leaks can be spotted immediately . . long before damage can be or has been done.

Six models help cut initial investment by providing a range of sizes to meet all drilling conditions at the lowest possible cost.

High performance of "D" Series pumps . . proved by years of drilling in the oil fields of the world . . assures penetration at its fastest rate.



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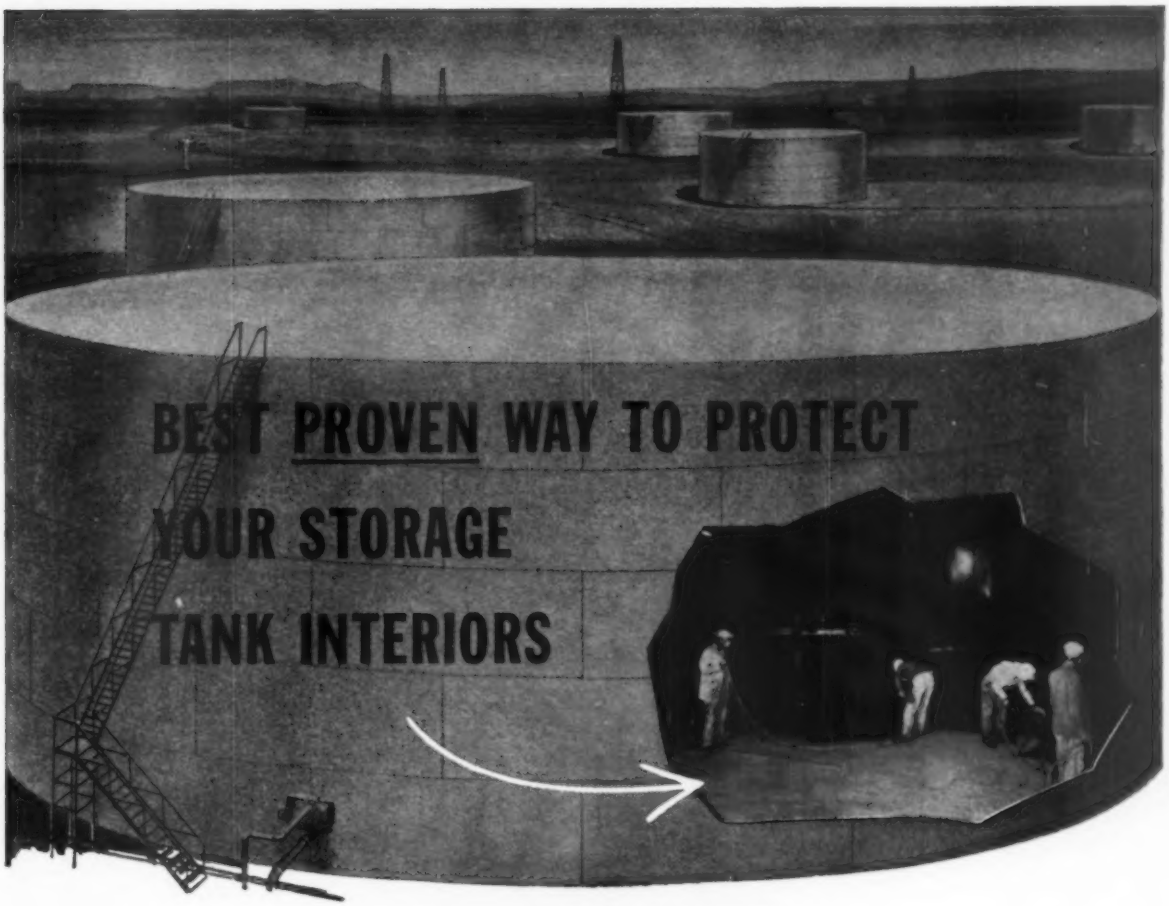

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TARSET is now available through your local industrial distributor. He has the know-how to help you solve your toughest corrosion problems. *Call him today!*

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Metallic back-stop is now available in Closed Type Cages by use of 18-8 insert in upper part of rubber guide. Ball never touches this metal in normal pumping.

Metallic back-stop is now provided in Open Type Cages by leaving cross bar above primary ball stop position. Ball never touches this metal in normal pumping.

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NOW EVEN BETTER!

The Martin Rubber Guide Idea, which has proven successful beyond anyone's expectation, is now available in improved form. The primary rubber ball stop for normal operation is now backed up by a metal stop to take the unusual ball impact which sometimes occurs.

Easily replaceable, mechanically held rubber guides often permit the renewal of cage life several times. They outlast metal by a great margin and usually increase ball and seat life two or more times.

Many production men specify MARTIN CAGES in all their pumps. Our cages are available in all sizes and types to take care of anyone's requirements.

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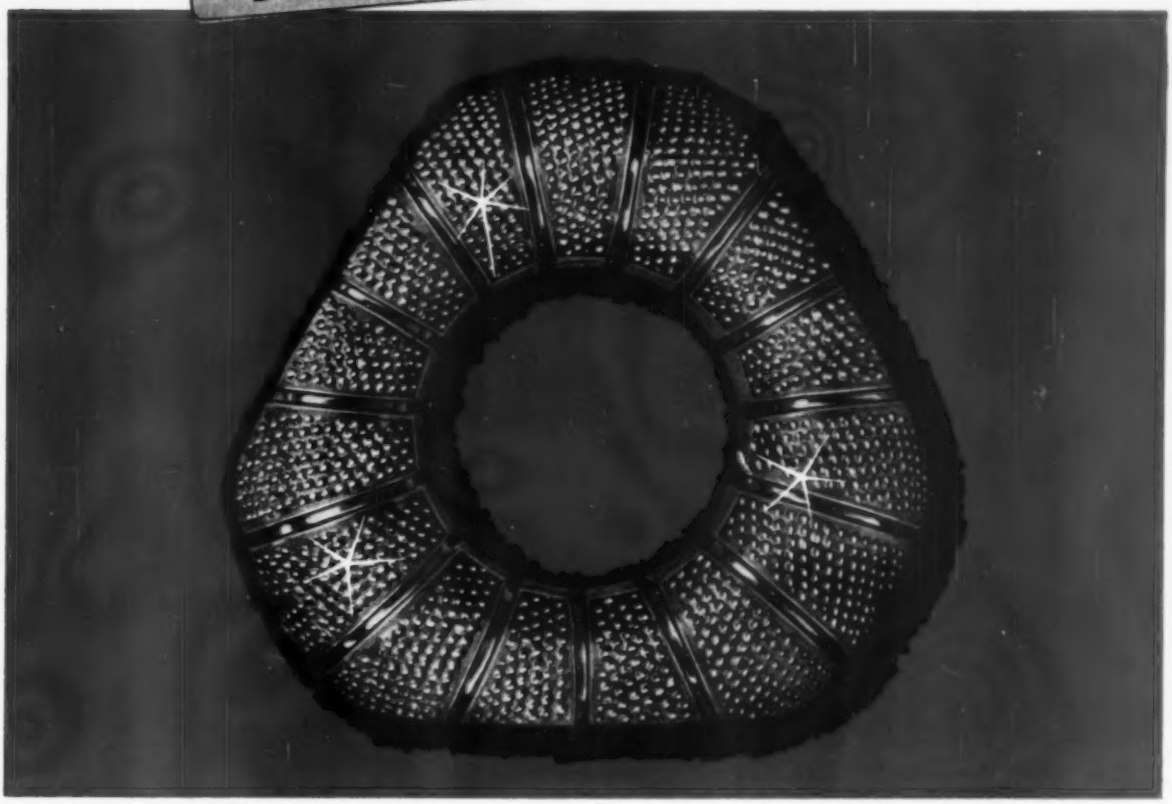

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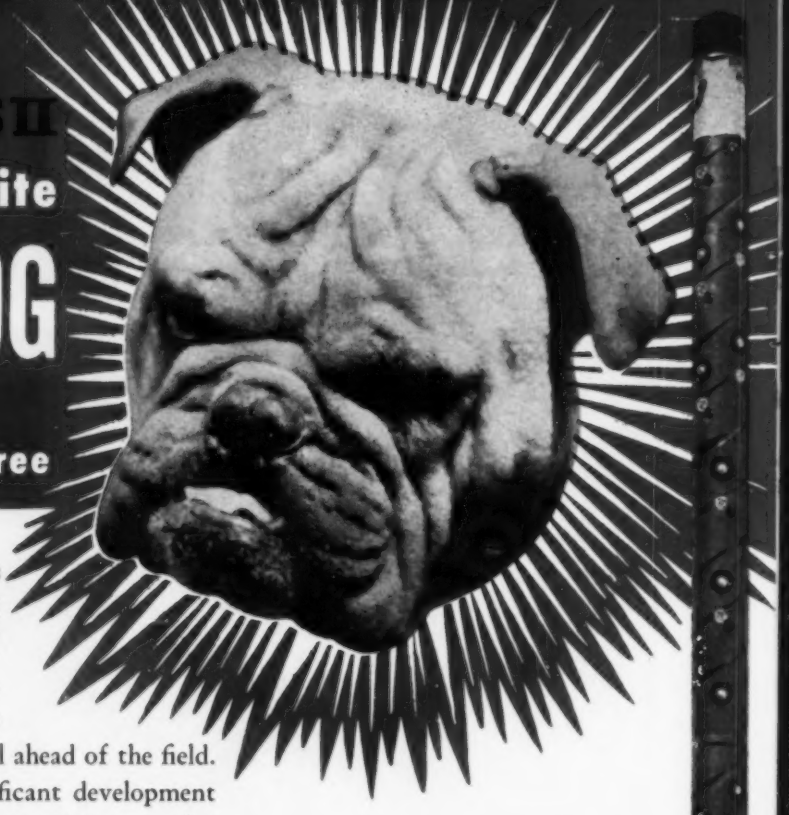

For the past 12 years leading operators have called PGAC's Atlas and Atlas II bullet guns the Oil Industry's *safest and most powerful bullet perforators.* PGAC's research improved these guns year after year and kept them always well ahead of the field.

Now, as the result of another significant development *—a new powder which increases penetration 70% over that of even the Atlas II*—PGAC hereafter designates this more powerful bullet gun as the "Atlas BULLDOG."

The Atlas BULLDOG retains all of the basic features and outstanding advantages of the Atlas and Atlas II guns.

That's why the Atlas BULLDOG now packs everything its famous forerunners had—*plus 70% more penetration!* "Get with" the Atlas BULLDOG today. You'll really go for this pedigreed champion of bullet guns!

Unretouched photo (lower left) shows the remarkable bullet penetration of over 9" from a 4" O.D. Atlas BULLDOG gun, typical of several test shots *fired under 2500 p.s.i. hydrostatic pressure at 180°F.* Tests with 5-7/16" O.D. Atlas BULLDOG guns produced much deeper bullet penetrations.

The targets were constructed *by a Major Oil Company,* and all tests were conducted recently *under their complete control.*

All targets had 7/16"-thick endplates (from flattened 9⅝" O.D., 43-lb., #N-80 casing) welded to 6⅝" O.D. pipe. Neat cement was cured seven days under water at 160°-180°F. and tested to a tensile strength averaging over 500 p.s.i.

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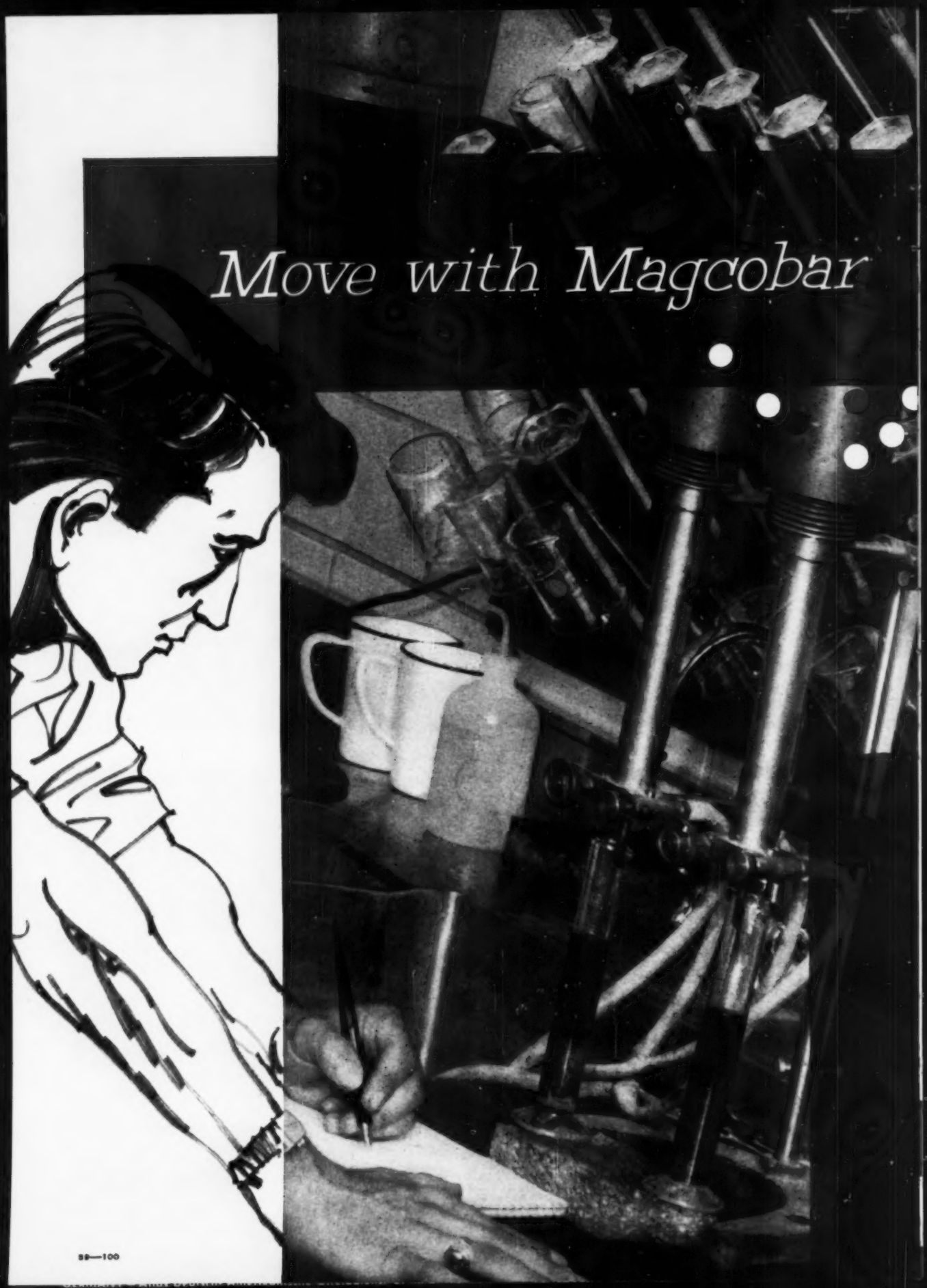
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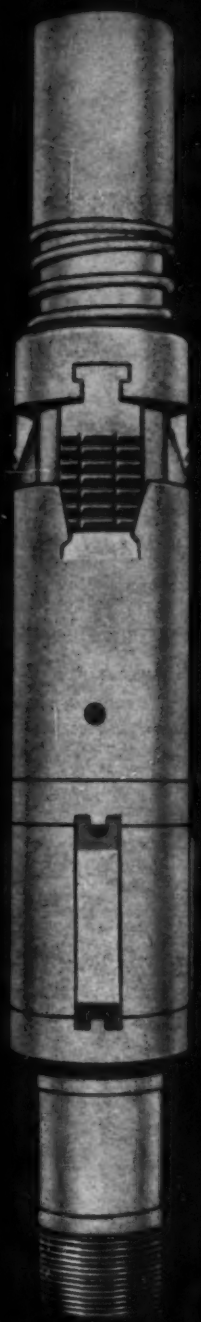

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A special report from . . .

U. S. WELL SERVICING CONTRACTORS

Important questions were asked on finances and equipment . . . and the answers make important reading for all who are interested in this vital segment of the petroleum industry

Jack W. Williamson, *Editor*

Contractors Make Progress

The stature of the well servicing industry has increased greatly in the past several years. A relatively small group of hard-working men of high caliber are the ones primarily responsible. These men are leaders in the well servicing industry in the many widespread areas of gas and oil operations. Through their outstanding leadership many other servicing contractors all over the U. S. are beginning to think constructively and cooperatively about their industry.

One important development has been the formation of the Association of Oil Well Servicing Contractors which now headquarters in Dallas, Texas. This rapidly growing organization is doing an excellent job of assisting its members with many of their industry-wide problems as well as acquainting all of the oil industry with these contractor's virtues and problems. It is also informing its own contractor members with some of the problems facing oil operators, their customers, today.

Because of the growing importance of well servicing to the oil industry, *The Petroleum Engineer* felt that its readers would be very interested in learning more about the present status of the well servicing business.

When studying an industry one should first get reliable facts about it. There are perhaps fewer known facts about the well servicing industry than any other business segment of this size in the oil industry. The people with the best knowledge of the well servicing business are the contractors themselves, so *The Petroleum Engineer's* editorial staff went directly to them in the form of a mail survey. We believe the results of this survey and its subsequent study will make important and interesting reading.

In recent months, most all gas and oil operations have increased in activity and it is hoped this increase will continue until a higher level of activity is sustained.

In summary, we feel that things are beginning to turn up for the well servicing industry too. 39 percent report their profits are as good or better than last year. 21 percent plan to buy more equipment this year than last. And 100 percent of the servicing contractors responding to this survey are now using qualified accountants to aid them in their business.

These contractors also have definite ideas on what kind of equipment they want built for them in the future and are fast weeding out older and outmoded equipment. Only one-third of their present equipment is over five years old. They are optimistic on the whole with 63 percent stating that well work will increase significantly within the next two years.

This report is divided into two sections—financial and equipment. Both of these sections reveal valuable facts on the well servicing industry as it stands today. The responding contractors have graciously submitted this information for your benefit.

THE FINANCIAL STUDY

Several questions involving finances were asked. Let's study the answers to these questions to see what we can learn.

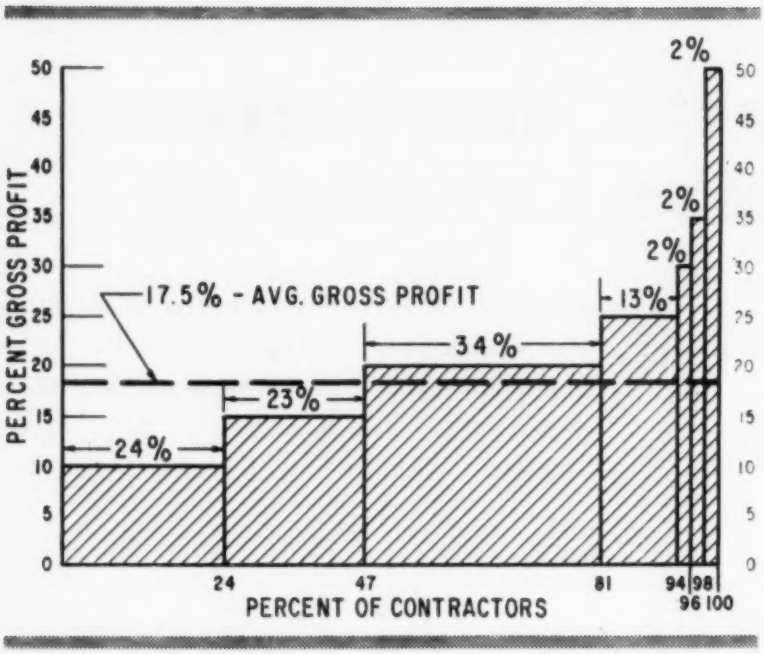
How much is a fair profit? The amount of gross profit considered necessary to make a fair net profit ranged from 5 to 50 percent, the average of all replies being 16.7 percent. Certainly this average figure would not be out of line in any industry. This very closely approaches the amount asked for by drilling contractors in another similiar survey reported in *The Petroleum Engineer* in October of this year.

How much price increase needed? The average of replies indicate that present prices should be increased 11.8 percent for contractors to realize a fair net profit. The range of increases asked were as low as 3 percent to as high as 30 percent.

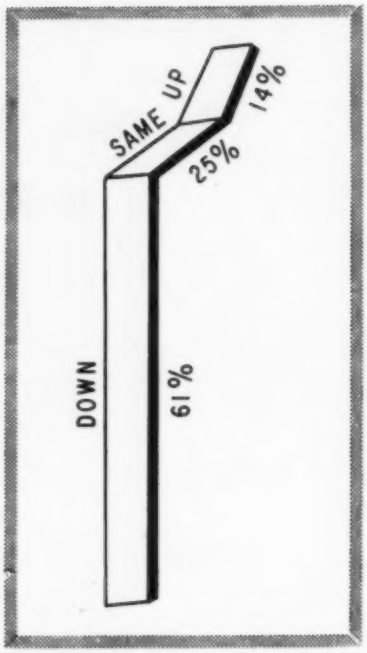
Are 1958 earnings up? Some are. Compared to 1957, however, a majority of 61 percent reported that earnings are down in 1958. It was encouraging that this group was not larger. 25 percent reported that earnings are about the same as last year and, more encouraging, 14 percent reported increased earnings for this year. These last two figures total 39 percent which means that reasonably close to one-half of these contractors have earned as much as last year or more.

BASIS FOR STUDY . . . *Well servicing contractors from nine gas and oil producing states graciously answered and returned THE PETROLEUM ENGINEER'S DATA SHEET. The list of survey respondents is broad enough to include most of the important geographical areas of gas and oil production. It also includes contractors who range in size from only one machine to some with large scale operations.*

A careful analysis was made of each data sheet and these data averaged to bring you direct answers from the contractors themselves so that you may examine your own position in relation to these results; you may also draw your own conclusions about the possible trends in future well servicing work.



What percent of gross income will permit a fair profit?



1958 earnings compared to 1957.

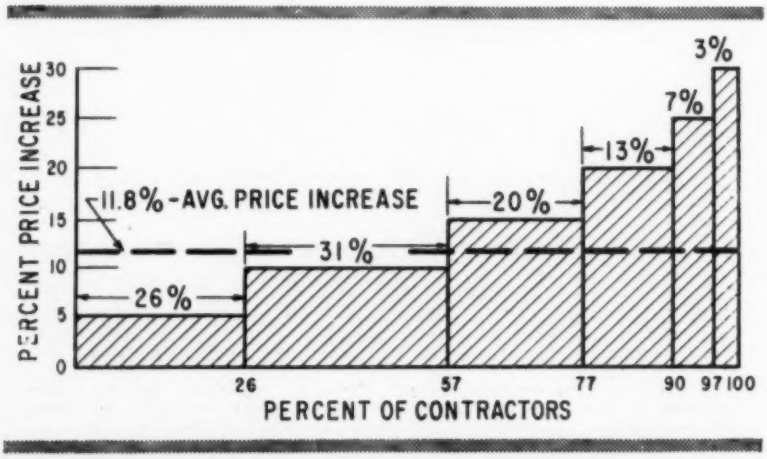
It is also encouraging to learn that the average decrease in earnings was only 19.6 percent as this figure was expected to be about twice this much. Those who reported increased earnings made an average of 9.2 percent more than in 1957.

Costs increase. All contractors have, of course, experienced increased costs on almost every hand. The average increase for the contractors reporting was 8.4 percent. Again, this figure agrees very closely with the increase reported by the drilling industry in the October issue of *The Petroleum Engineer*. Oil well servicing contractors surveyed say that equipment and materials accounted for 85 percent of the increases and labor 15 percent.

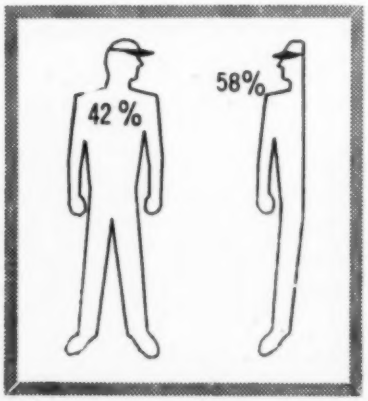
Future purchases. The picture is still glum here as 79 percent say they will purchase less equipment than in 1957. The industry is not yet through the period of disposal of surplus equipment. It is believed, however, that the current up-swing will again employ, by possibly 1960, most of this excess equipment that now exists. The equipment picture will also be improved in the future by important advancements in new models which will do well servicing jobs faster and safer. Though rig improvements and model changes will eventually cause a significant increase in rig sales, a greater demand for petroleum products will be the most important factor increasing sales.

Use of accountants growing. More contractors are using accountants part and full-time. They are fast realizing that good accounting practices mean more than just recording the bills that have been paid and knowing the amount of the bank balance occasionally. Another article in this issue of *The Petroleum Engineer* written by Frank Pool of San Angelo, Texas, describes how good accounting records can be used to help the oil well servicing contractor in many ways.

58 percent reported they were using an accountant part-time and 42 percent employ a full-time accountant. 68 percent of these contractors receive a report from their accountants monthly and 32 percent receive reports quarterly.



How much should prices be increased to realize a fair profit?



Good progressive accounting consists of more than just "balancing the books" every so often . . . are you using this valuable tool to its full advantage?

THE EQUIPMENT STUDY

A number of questions were asked the contractors about their equipment . . . we think you will be interested.

What do rigs do? To get an idea of how much time is spent on various types of well servicing jobs each contractor was asked to give a job breakdown for all his servicing units. After averaging the results it was found that 17 percent of the jobs were swabbing, 48 percent rod and tubing and 35 percent workover jobs.

In some areas contractors have units which are rigged for swabbing purposes only and others have units that are kept busy on workover projects 100 percent of the time. The percentages listed above are for operations all over the U. S. and any specialized or local area work that is different from the general type work, would not show up.

What is the average servicing depth? For swabbing operations it is 5900 ft; for rod and tubing jobs 5600 ft; and 6200 ft for workovers. This is about as expected and we know which direction it is going . . . deeper.

How many sizes of rigs should there be? If you were faced with the problem of designing three rigs to service all depth ranges, what depths would you choose for each rig. Averages of replies received would have the shallow rig handle the depth range from grassroots to 4500 ft, the medium depth rig from 4500 to 8000 ft, and the deep rig from 8000 to 14,000 ft. How do these depth divisions agree with the ones you may have in mind?

How heavy? The average of all replies on the maximum weight any well servicing unit should weigh for practical "over the road" travel turned out to be 60,000 lb. Most influencing factor here, of course, is the weight limit set by each state.

How wide? Again, state laws dominate the answers which were: 8.4 ft for width, 49.7 ft for length and 12.8 ft for height. Would these maximum weight and dimension limits get you over most of the highways in your state?

How do you want your unit mounted? There are three commonly used methods of mounting well servicing equipment to achieve portability. In an effort to see in a general way what is the present choice of well servicing contractors, they were asked to list their perference. 65 percent prefer a truck mounted unit. 13 percent prefer trailer mounted and 22 percent want it mounted on a self-contained chassis.

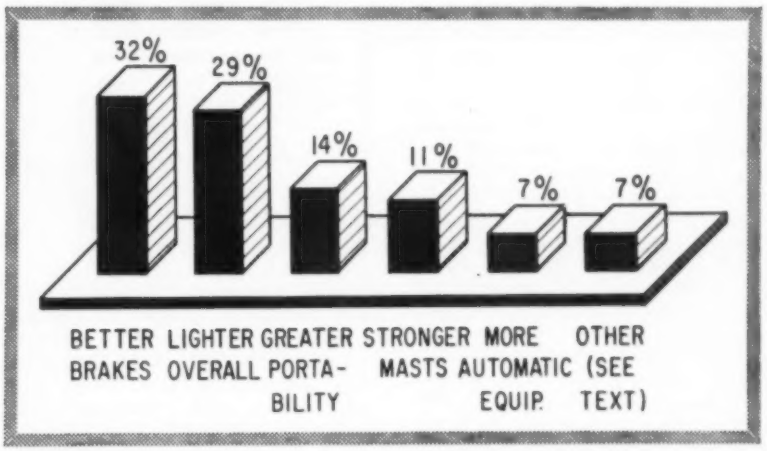
So many things enter into the choice of mounting a unit that we would like to make reservations on the use of the answers to this question in regard to future trends. It could be that when future designs of self-contained units have been improved further and when more are working in the field, a greater number of contractors will choose this type mounting. However, we think it does reliably show present preferences and these perferences may continue to dominate in the future.

Where should the engine be located? On units where there is a choice, contractors were asked to indicate their preference of using the truck engine or a separately mounted engine for power to operate the hoist. It was found that 73 percent prefer a separate engine.

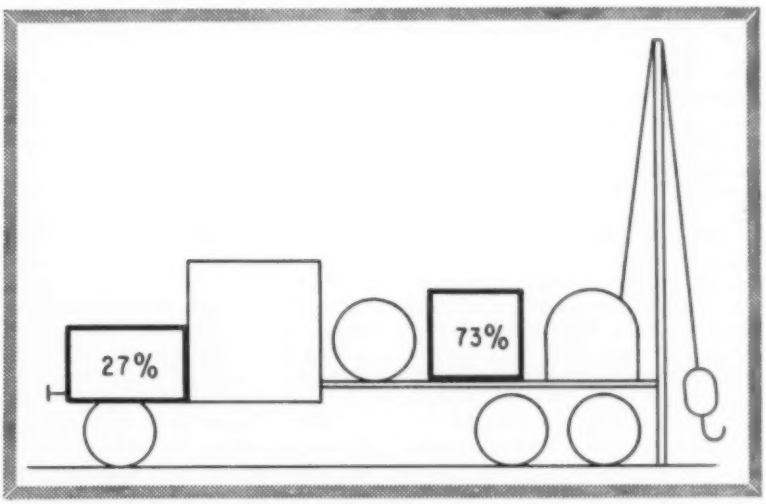
Accessory equipment. Power tongs have been one of the most successful developments of new semi-automatic tools. The question has arisen many times, however, as to whether their use is justified in servicing shallow wells. One of the survey questions asked if power tongs saved enough time to warrant use on wells less than approximately 3000 ft deep. 65 percent answered yes. This would indicate that the majority of contractors plan to use power tongs on all their rigs.

How old is the majority of servicing equipment? 34 percent are over 5 years old. If more than a third of your equipment is over 5 years old you are not keeping up with the "Jones' " in the average oil patch.

Rig obsolescence. In an effort to determine how fast servicing units were being disposed, contractors were asked to list how many rigs they had junked in 1958. The average figure was 0.36 rigs per contractor. Estimating there are some 3000 servicing rigs in exist-



32 percent of the contractors replying chose better brakes as their most-wanted improvement . . . what major improvement do you want the most?



Which location do you prefer for the engine used to operate the hoist? 73 percent wanted a separate engine located near the hoist . . . against 27 percent preferring to use the truck engine.

ence which are operated by less than some 1000 contractors, the average rig ownership would be three-plus per contractor. This will give a relative measurement of the effect of obsolescence on the rate of rig decline.

Want any major rig changes? Taking the lead vote in this survey, better brakes were desired by 32 percent of the contractors. They want larger and water cooled brakes. Several wanted hydraulic brakes. There was also mention that the location of the brake controls on some units did not permit the operator the best possible view of the floor and derrick operations.

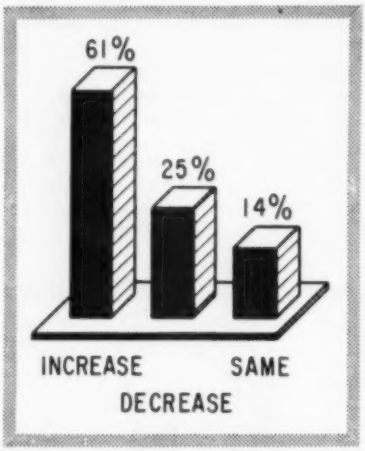
Running a close second, 29 percent want the entire rig to be lighter. Apparently highway laws are not getting any more lenient and, of course, a lighter rig has many other advantages. Closely tied with this need is one for greater portability and maneuverability. 14 percent wanted these improvements above all others.

Careful, don't pull in the mast! Bent, thrown over and otherwise damaged masts are by far the most common insurance claim from servicing units. What percent of this trouble could be eliminated by the "world's best-ever built mast" is problematical because operators themselves are many times responsible for mast damage. For example, insecure dead men for guy lines can wreck a mast when one is pulled loose. However, stronger and lighter masts are needed. In fact, 11 percent voted for stronger masts as their most wanted rig improvement. This requirement can't be met by just beefing up the present designs. Manufacturers have been working hard on this difficult engineering feat and have certainly made some wonderful improvements which are available in some of today's latest rigs.

The demand for automatic equipment on the rig is moving up fast. If these improvements are not priced out of the market they will find wide acceptance. They will help the contractor keep his prices lower and permit him to do a better and faster job for his customers. This survey shows that 7 percent want more automatic equipment.

There are many facets to the automatic equipment picture. For example, if a manufacturer develops a new tool such as hydraulic operated tongs, the contractor wants the hydraulic power to run these tongs to come from the rig and not from a separate power unit. In other words the entire rig and all its components should be designed for each other in order to achieve a maximum of efficiency and flexibility. Further, if the power tongs use hydraulic power, the other power components should also use hydraulic power.

Other needed improvements. The remaining 7 percent of "first requested improvements" were too numerous to be grouped. Some of them are: Permanent lighting, drawworks more easily accessible for repair, stronger power take-off's, improved hydraulic systems, better adaption of rigs for use with a substructure, ground controls for the operator on all small rigs and rigging to permit the blocks to stay strung up on moves.



Well servicing work will increase within the next two years, say 61 percent of the replies . . . what is your opinion?

Unit downtime. Downtime for mechanical repairs can be very expensive to a contractor. Sometimes installation of needed parts and labor are only a fraction of what it may cost him in lost working time. Manufacturers are well aware of the need for reliability and long service for its equipment. They continually strive to achieve this in design; manufacture; in the placing of complete parts stocks and trained service personnel in every key area that will support these facilities. The record is good on this, but of course further improvements can and will be made as technology advances.

Heading the trouble list is engines, 44 percent of the contractors had their most downtime and expense with engines. Many factors enter this picture . . . overloading by improper operation and equipment being under-powered. Improper, or lack of regular servicing can mean all the difference here.

Brakes popped up again, in second place this time by giving 23 percent of the contractors the most downtime. Clutches followed with 19 percent, and chains 6 percent. Small chains gave the most trouble. The remaining 8 percent of downtime items were in many other departments such as in the transmission, the hoist, and the truck itself.

OTHER CONSIDERATIONS

Well Records

More contractors are keeping permanent well servicing records for the customers use as well as their own. In answer to the question whether their customers were using these well records, 42 percent of the contractors replied yes, 12 percent some, and 46 percent no.

Contractors who do use these records find them convenient for quick reference in the field and as a double check of their own records. For smaller oil operators who do not have duplicate records, they can be valuable in case of a total loss by fire, or otherwise. Some operators, however, do not have any use for these records.

Standard Servicing Contract?

In the oil well drilling business it is a standard procedure to obtain a contract signed by all interested parties before drilling the well. Oil well servicing contractors were asked if they desired a counter-part to the drilling contract — 70 percent replied yes.

What About the Future?

Finally, contractors were asked to express their outlook regarding well servicing for the next two years. 63 percent anticipate increased well work. Primary reason is that wells continue to decline and require more servicing. The number of wells are increasing significantly each year and many, of course, are hopeful that drilling will greatly increase.

SUMMARY

Take A Second Look

Now that you have some facts about the well servicing industry, how does your own operation compare with the average? Do you need about the same price increase to make what you consider a fair profit? Were you among the contractors whose earnings were higher this year than last year? And, are you using your accounting records to your best advantage?

Is more than one-third of your equipment over 5 years old? Are you as optimistic about the future well work in your area as the majority over the U. S.? By carefully studying the answers given in this survey in the light of your own operations we hope that you, Mr. Contractor, will find something useful.

It is also hoped that oil producers, equipment manufacturers and other interested parties will benefit from this review of a most valuable member of the oil fraternity . . . the progressive well servicing contractor. ★ ★ ★

Practical Accounting for the Servicing Contractor

- **Adequate accounting systems show more than profit-loss picture**
- **Contractor must be able to present a program of profits**
- **He must have borrowing program — with established paying record**
- **Cost analysis permits application of new methods, improved services**

Frank M. Pool
President, Pool Well Servicing Company
San Angelo, Texas

A PRACTICAL accounting system for any business must chronicle business operations in permanent-record form so classified as to

—VERIFY compliance with law and regulatory-body requirements; and,

—FURNISH management its indispensible tools for controlling present, and planning future, operations.

It must do both. If it serves only the first purpose, it may well deserve the "necessary evil" label so frequently attached to any non-productive function of a business. When both requirements are met, it becomes a valuable segment of the business — one that earns its keep as much as any operating department producing direct revenue.

The burr under the saddle is the word "practical." Certainly a business that lends itself so well to statistical analysis, as does the service contractor's, because almost all of its activities can be reduced to indisputable figure facts, can be clothed in an accounting ensemble that will satisfy the critical eyes of management, the customer, and Uncle Sam alike. The trouble is that such a system can — and often does — create a situation of "the tail wagging the dog."

An accounting system is by definition and implication more than the bookkeeping chore of recording the activities of a business on its journals and ledgers. Accounting concerns itself with analyses of the financial position and operating results. To that end, it must *classify* and *evaluate* the figure facts of business transactions. Before it can classify and evaluate facts, it must *collect* them; thus its first mandate is that it provide for systematic and *timely* collection of *all* operating data *accurately* recorded on "source documents" that have been, or can be, *verified*.

News and History

Fundamentally, the accounting records of a business reflect its assets and liabilities on the balance sheet (or financial statement) *as at* a specified date (Fig. 1), and summarize its operations in terms of income and expenses on the profit and loss (or operating) statement *for* a designated period (Fig. 2). One might say that the balance sheet pictures the accumulated results of a business' operations from the day it came into being, whereas the operating statement shows only the results of its operations for one relatively short span of its business life — the accounting period. Thus, for a going concern, the operating results by and large create the changes in the financial condition of a business as shown on its balance sheet.

The operating statement shows what a business *is* doing and what it likely is *capable* of doing; the balance sheet shows what it *has* done. One is *news;* the other is *history*. Management, owners, customers, even creditors are attaching ever greater importance to what a business is *doing* and likely *can do*, rather than what it *has done*. This treatment consequently emphasizes the accounting data for the operating statement. The balance sheet accounts may be as general or detailed as management considers necessary. A system of balance sheet account classification as shown in Fig. 3 is the extent of treatment given these accounts in this article.

Profit Motive

A business must *produce profits* if it is to exist, and it must *retain* a part of these profits if it is to survive. Profits, as we all know, are the excess of earnings over the costs and expenses incurred to produce these earnings. Profit can only be created by *increasing* income or *decreasing* expenses.

The contractor sells service. Assuming other factors to be equal, the price he puts on his service must be as low as his competitor's and lower than what it would cost the customer to be a "do-it-yourselfer." Thus, he has very little effective control over the price he charges per unit of service sold. It is fixed by public acceptance and competition. The only way he can increase gross *income* from day to day is to sell more service — quantitatively, again assuming quality and other factors that constitute customer acceptance as being equal.

But volume alone won't produce profits.

If to produce a unit of service costs as much as, or more than, that unit is worth in revenue, sheer volume for that contractor only hastens the day when he ceases to be a marginal operator and becomes just another business failure statistic. It follows, then, that the area most likely to yield benefits from constant scrutiny of accounting records is in the controlling and *reducing* of operating expenses. Suffice it to say that income should be classified as to source, and to distinguish between what is *earned* and what is merely a *recovery of expenses* funded for the customer by the contractor as a matter of accepted practice or courtesy — such as third-party charges, swab cups and oil saver rubbers, bits,

etc. Fig. 4 is an example of income-account classification.

Pinpointing the Expense

In the area of accounting for expenses and costs, the goal is to isolate or identify each expense or cost component down to the smallest detail within the limits of practicability. Expenses and costs are fixed or variable; direct or indirect (apportioned); productive or non-productive; tax deductible or non-deductible. There is frequent need to identify them with a particular department, district, job, unit of equipment, time period, person responsible for incurring them, category. Only practicability imposes any limit to the number of different groupings necessary or desirable. To be practical, a satisfactory system of expense classification should show both the forest and the trees; it should fit both the small and the large operator; it should be adaptable to maintenance by either manual or mechanical means (Fig. 5).

Recording

The mechanics of recording factual data from source documents may be handled in one of two ways:

1. Maintain separate accounts for each of the smallest classifications of account wanted, and consolidate these into consecutively larger divisions or groupings (Fig. 6); or,
2. Maintain separate accounts for only the broad, general groupings but in sufficient detail to permit isolation of the smallest sub-classifications when necessary (Fig. 7).

Either method demands from the source documents (payroll time tickets, field work orders, vendors' invoices, store charges, reports, etc.) *accuracy, completeness, timeliness* and *verification*. These documents should contain all the information, down to the smallest sub-classification, that may need to be extracted from them. They should answer all the questions in *Who* did *What*, and *How*, *Where*, *When* and *Why* — Kipling's

> "— six faithful servant men
> Who taught me all I knew;
> Their names were *WHAT* and
> *WHERE* and *WHEN*, and
> *HOW* and *WHY* and *WHO*"

ANY WELL SERVICING CONTRACTOR

BALANCE SHEET
December 31, 1958.

ASSETS

Current Assets

Cash on Hand	$ ____	
Cash in Bank - Restricted Account	____	$ ____
Accounts Receivable - Trade		____
Accounts Receivable - Other		____
Accounts Receivable from Employees		____
Prepaid Expenses:		
Prepaid Insurance	____	
Prepaid Interest	____	
Prepaid Rent	____	____
Materials & Supplies Stocks		
General Supplies	$ ____	
Fuel & Lubricants	____	
Swab Cups & Oil Saver Rubbers	____	
Tires & Tubes	____	
Wire Line	____	
	____	____
Total Current Assets		$ ____

Fixed Assets & Equipment	COST	ACCUMULATED DEPRECIATION	BOOK VALUE
Well Servicing Equipment	$ ____	$ ____	$ ____
Communication Equipment	____	____	____
Transportation Equipment	____	____	____
Etc.			
Total Fixed Assets			$ ____

Other Assets	
Notes Receivable	
Investments	
Due from Affiliates & Subsidiaries	
Etc.	
Total Other Assets	$ ____
TOTAL ASSETS	$ ____

LIABILITIES

Current Liabilities

Bank Overdraft - Checking Account	$ ____	
Bank Overdraft - Payroll Account	____	$ ____
Accrued Payroll		
Accounts Payable - Trade		____
Accounts Payable - Other		____
Accrued & Withheld Payroll Taxes		____
Withheld Group Insurance Premiums		____
State Taxes Payable (Such as State Sales or Occupation Tax)		____
Accrued Interest		____
Notes Payable - Due Within One Year		____
Total Current Liabilities		$ ____

Fixed Liabilities	
Notes Payable - Maturing After One Year	____
* Investment:	
Investment - Partner "A"	____
Investment - Partner "B"	____
Total Investment	____
TOTAL LIABILITIES	$ ____

* This section of Liabilities -- what the business owes its Owners--has to be modified to fit the particular type of business organization and to reflect how the liability to the Owners is evidenced --- PROPRIETORSHIP, PARTNERSHIP or if a CORPORATION, a classification of its stock and surplus.

FIG. 1. Balance sheet for servicing contractor includes what he owes, what he owns, and what is owed to him.

ANY WELL SERVICING CONTRACTOR

STATEMENT OF INCOME AND EXPENSES
For the Period
(From) (To)

Operating Income		
Earned Income from Services Rendered:		
Well Servicing Units Hourly Revenue	$ ____	
Roustabout Gangs Hourly Revenue	____	
Reverse Circulator Revenue	____	
Trucking Operations Revenue	____	
Maintenance Shop Revenue	____	$ ____
Administrative Services Revenue	____	____
Materials Furnished & Charged		____
Third Party Charges Billed to Customers		____
Auxiliary Equipment Income		____
Total Operating Income		$ ____

Operating Expenses		
Wages & Salaries	$ ____	
Owner's(s)' Compensation	____	
Equipment Repair & Maintenance	____	
Auto & Truck Expense	____	
Materials & Supplies	____	
Contract services & Equipment Rentals	____	
Travel & Crew Expense	____	
Insurance	____	
Utilities	____	
Rent	____	
Professional Fees	____	
Communication Expense	____	
Taxes & Licenses	____	
Public, Trade & Employee Relations:		
Dues & Subscriptions	$ ____	
Advertising	____	
Sales Promotion	____	
Employee Relations	____	
Public Relations	____	____
Safety Program Expense		____
Aircraft Operating Expense		____
Miscellaneous Operating Expenses		____
Casualty Losses	$ ____	
Less: Recovered by Insurance Settlements	____	____
Total Out-of-Pocket Expenses		$ ____
Depreciation		____
Total Operating Expenses		$ ____
Net Operating Income (or Loss)		$ ____

Other Income		
Oil & Gas Sales	$ ____	
Less: Production Expenses	____	$ ____
Discounts Earned		____
Gain (or Loss) on Disposition of Assets		____
Total Other Income		+ ____

Other Expenses		
Discounts Allowed on Materials Furnished & Interest on Book Charges	$ ____	
Bad Debts	____	
Total Other Expenses		- ____
Net Income (or Loss) for Current Accounting Period		$ ____
Adjustment for Prior Accounting Period Expenses and/or Income		____
Net Gain (or Loss) - Taken into Account this Accounting Period		$ ____

FIG. 2. Statement of income and expenses. This is an analysis of the contractor's spending and income, showing net income or loss and net gain or loss during a particular accounting period.

All the Information

Importance of the source documents cannot be over-emphasized. They are the diary, the "morning paper" of the business. They are the front line dispatch that tells headquarters what goes on "at the front," in the field. And there—*in the field*—is where they have to be made, *as* things are happening, *by* the men who make them happen, *as* they have been instructed to make them. Headquarters can evaluate and process these dispatches, but it cannot write them. Hitler tried that in the waning moments of World War II in Europe; his headquarters dispatches didn't go over very big.

The content of these source documents must be prescribed and uniform; they should give *accurate* information, and *all* of it. Partial information too often distorts the facts completely. For example, here is an accurate statement: "In the race, my car came in second; your car ran next to the last." So far, my car did pretty good. But if I tell *all* of the facts, the impression is quite different: "In the race between our two cars, my car came in second; your car ran next to the last." Now *you've* got a winner, and mine ran *last!*

Time Denominator

Formal accounting records too often limit their information to dollars and cents. A common denominator is, of course, necessary, particularly in accounting. You can't compare apples with oranges. But to confine all accounting data to dollar-and-cent figures is a common fallacy. Unless you know that Unit No. 2 uses a 10,000-ft sand line and Unit No. 1 an 8000-ft line, a comparison of strictly replacement *cost* of sand lines between the two units would be disturbing. Because so much of the contractor's stock-in-trade — *service* — is measured by the hour, accounting records should adopt the hour as *a* common unit of measure in addition to the conventional dollars and cents.

Over the years, the drilling industry

ANY WELL SERVICING COMPANY
INCOME AND EXPENSE SUMMARY BY UNIT

INCOME	FY TO DATE	FY TOTAL THRU PREV. MONTH	UNIT # CURRENT MONTH
Earned Hourly Income			
Material Furnished & Charged			
Third Party Charges			
Auxiliary Equipment Billed With Unit Charges			
Total Income:			
EXPENSE			
Direct Charges:			
514 - Labor, Productive			
519 - Nonproductive Labor			
521 - Repairs & Maintenance, General			
522 - Repairs & Maintenance, Draw Works			
523 - Repairs & Maintenance, Engines			
524 - Repairs & Maintenance, Wire Line			
X31 - Repairs & Maintenance, Auto & Truck			
X32 - Gasoline & Oil, Auto & Truck			
X33 - Tires & Tubes, Auto & Truck			
541 - Expendable Supplies			
542 - Tool Replacement			
543 - Swab Cups & Oil Saver Rubbers			
544 - Fuel & Lubricants			
551 - Hauling & Winch Work			
552 - Equipment Rental			
553 - Purchased Services			
560 - Travel & Crew Expense			
581 - Hazard Insurance			
582 - Public Liability & Property Damage			
583 - Workmen's Compensation			
591 - Miscellaneous Expenses			
599 - Clearing Account (Third Party Charges)			
Total Direct Charges:			
Overhead & Prorated Charges:			
Depreciation			
Shop			
Administrative & General Expense			
Managerial			
Total Overhead & Prorated Charges:			
NET PROFIT - (Or LOSS)			

FIG. 2A. Individual servicing units must account for their share of the firm's income and expense, and all charges and income billed accordingly to the proper classification.

BALANCE SHEET ACCOUNT CLASSIFICATION

ASSETS

11. CURRENT ASSETS
  111. CASH
    1111. Cash on Hand
    1112. Cash in Banks
      11121. Checking Account
      11122. Restricted Account
      11123. Payroll Account
      11124. Purchasing Agent's Account, etc.
  112. ACCOUNTS RECEIVABLE
    1121. Accounts Receivable, Trade
    1122. Accounts Receivable, Other
    1123. Accounts Receivable From Employees
  113. PREPAID EXPENSES
    1131. Prepaid Insurance Premiums
    1132. Prepaid Interest, etc.
  114. MATERIALS & SUPPLIES STOCKS
    1141. General Supplies
      11411. District "A"
      11412. District "B", etc.
    1142. Fuel & Lubricants
      11421. District "A"
      11422. District "B", etc.
12. FIXED ASSETS & EQUIPMENT
  121. Well Servicing Equipment
    12101. Well Servicing Unit #1)...Specific identification of a UNIT
    12102. Well Servicing Unit #2
  122. Communication Equipment
    1221. Base Station Equipment)...Specific identification by Type or Use
    1222. Mobile Units
  123. Transportation Equipment
    12301. Vehicle #1)...Specific identification by VEHICLE
    12380. Vehicle #80
  124. Furniture, Fixtures & Office Equipment
    1241. "X" Years Useful Life ..... Specific identification by ESTIMATED LI
      12411. District "A")...Specific identification by LOCATION
      12412. District "B"
    1242. "Y" Years Useful Life
      12421. District "A"
      12422. District "B"
13. OTHER ASSETS
  131. NOTES RECEIVABLE
    1311. Notes Receivable - Secured
    1312. Notes Receivable - Open
  132. INVESTMENTS, etc.

LIABILITIES

21. CURRENT LIABILITIES
  211. Accrued Payroll
  212. Accounts Payable
    2121. Accounts Payable, Trade
    2122. Accounts Payable, Other
  213. Reserves For Payroll Deductions
    2131. Federal Income Tax Withheld
    2132. State Income Tax Withheld
      21321. Texas . . . .
      21322. Colorado
  214. Notes Payable - Due Within One Year
22. FIXED LIABILITIES
23. ALLOWANCE FOR DEPRECIATION
  231. Well Servicing Units
  232. Communication Equipment
  233. Transportation Equipment, etc.
24. OTHER LIABILITIES

3. NET WORTH (or CAPITAL)

  31. PROPRIETORSHIP or PARTNERS' INVESTMENT (or CAPITAL STOCK)
    311. Partner "A" Capital (or Common Stock, Par Value)
    312. Partner "B" Capital (or Common Stock, No Par Value)
  32. PROPRIETOR'S or PARTNERS' DRAWING ACCOUNTS (or PAID IN SURPLUS), etc
  33. EARNED SURPLUS
    331. Earned Surplus, Appropriated
    332. Earned Surplus, Unappropriated

FIG. 3. Classification of each account listed on the balance sheet permits pinpointing and following every company function that in the end affects business well-being. →

has developed a yardstick by which to measure performance and which is commonly accepted by the drilling contractor and the customer as a constant and reliable factor—*the foot*. Penetration rate, cost of bidding on and cutting hole, and bit performance — to mention a few — are reckoned and stated on the "per foot" basis. By the same token, the service contractor must adopt a common-denominator yardstick by which to measure his performance. He has available in most of his accounting records, and needs only to put to use, such a unit of measure, namely *the hour* of service — labor from his employees and third-party services he buys, and revenue time he sells to the customer.

The need for *timeliness* in source documents, formal accounting records, and the reports to management extracted from the accounting records is so obvious it needs no further elaboration.

One System?

What about *verification?* Isn't that the auditors' job? Only in one sense. Verification as here used is substantiation of facts not only to management and government, but to the customer, employee and supplier as well. Obviously, it is not feasible, necessary or desirable that each element with whom the contractor deals receive all the information collected by the contractor. However, each element is entitled to and may well demand substantiation of the figure facts that reflect its dealings with the contractor. What is needed, then, is a system that will tell both the contractor and with whomever he is dealing the full facts of the transactions between the two of them. This should and almost *has* to be a by-product of the process whereby the contractor records the operating data on his own books and for his own use. He could ill afford a separate accounting system for each separate end purpose; one system must serve all purposes.

Verification

Take an hour of payroll time, for example. It should be so recorded from whatever source document is used that:

1. The employee can verify to his own satisfaction that he is being paid the promised rate for the number of hours he put in on the various jobs he was assigned during the pay period;
2. The customer can verify that he is paying for only those hours worked by the contractor's employees for which he, the customer, agreed to pay;
3. Uncle Sam can satisfy himself that every hour worked by each employee in "covered" employment in excess of 40 hours in any one week is compensated for at one and one-half times the established rate of pay per hour for that particular occupation, and that both the employer and the employee have paid their respective share of contribution to the old age retirement fund on the first $4200 paid any one employee by any one employer in any one calendar year, and that the employer has faithfully

INCOME CLASSIFICATION

4. INCOME

- 41. Earned Income From Services
  - 411. Well Servicing Units
    - 41101. Unit #1
    - 41102. Unit #2, etc.
  - 412. Roustabout Gang
  - 413. Reverse Circulator
  - 414. Trucking Operations
- 42. Material Furnished & Charged
- 43. Third Party Charges Billed to Customers
- 44. Oil & Gas Sales
  - 441. Oil Sales
  - 442. Gas Sales
- 45. Other Income
  - 451. Interest Earned
  - 452. Discounts Taken
    - 4521. Cash Discounts
    - 4522. Trade Discounts
  - 453.
- 46. Gain (or Loss) on Disposition of Assets
  - 461. Gain (or Loss) on Sale of Assets
  - 462. Gain (or Loss) on Involuntary Conversion of Assets
- 47. Etc.
  - Etc.
- 48. Etc.

FIG. 4. **Income classification** locates income by units, various field operations, third party charges, sales, earned interest and discounts taken.

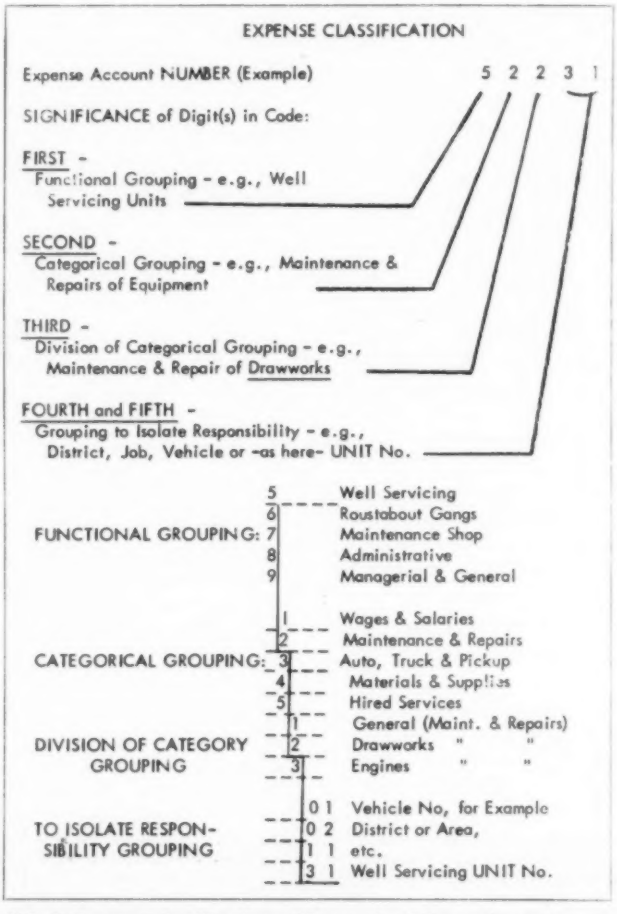

EXPENSE CLASSIFICATION
Expense Account NUMBER (Example)
5 2 2 3 1
SIGNIFICANCE of Digit(s) in Code:
FIRST - Functional Grouping - e.g., Well Servicing Units
SECOND - Categorical Grouping - e.g., Maintenance & Repairs of Equipment
THIRD - Division of Categorical Grouping - e.g., Maintenance & Repair of Drawworks
FOURTH and FIFTH - Grouping to Isolate Responsibility - e.g., District, Job, Vehicle or -as here- UNIT No.
FUNCTIONAL GROUPING:
5 Well Servicing
6 Roustabout Gangs
7 Maintenance Shop
8 Administrative
9 Managerial & General
CATEGORICAL GROUPING:
1 Wages & Salaries
2 Maintenance & Repairs
3 Auto, Truck & Pickup
4 Materials & Supplies
5 Hired Services
DIVISION OF CATEGORY GROUPING
1 General (Maint. & Repairs)
2 Drawworks " "
3 Engines " "
TO ISOLATE RESPONSIBILITY GROUPING
01 Vehicle No, for Example
02 District or Area,
11 etc.
31 Well Servicing UNIT No.

FIG. 5. **Expense classification,** with example of how code numbers are used. This card, numbered 5 2 2 31, tells us that Well Servicing Unit No. 31 has had maintenance and repair work on its drawworks.

discharged his duties as the agent (without pay or other reward) of the government to collect from each employee his share of the federal (or state) tax burden, ad infinitum . . .

4. The insurance agent can vouch to his company that he collected the workmen's compensation and public liability premium due on all straight time wages paid by the contractor during the policy year for all covered types of labor performed;
5. The contractor can feel reasonably sure that every one else's requirements have been met, and that the right number of wage dollars have been paid to the man who earned them. Consider now that:

The employee wants to verify his time, say *every other week;*
The customer — *upon completion of the job;*
Uncle Sam — *monthly, quarterly,* and *annually* on the *calendar year* basis;
The insurance agent monthly on the *policy year* basis;
and the contractor on the *fiscal year* basis.

At this point anyone can see that one system won't take care of all requirements. But . . . more than one is impractical; it could be a "tail wagging the dog" situation. The solution is obviously not an easy one. It demands real ingenuity and some original thinking. At times it looks like we'll have to discard the old maxims of "two and two make four" or "There are only 24 hours in a day."

A *practical* accounting system for the service contractor? Perhaps the emphasis should better be placed on *A* practical system, denoting one of several possible ones. Certainly no one system can be adopted without change by everyone in the business. However,

FIG. 6. Consolidation of Account Classifications.

	Well servicing operations (Expense group no. 5)	Roustabout gang operations (Expense group no. 6)	Maint. shop operations (Expense group no. 7)	Office & administrative (Expense group no. 8)	Managerial & general (Expense group no. 9)
-1 LABOR—Salaries & Wages				8111–Home Office	
—11 Productive labor	511 51101–Unit #1 … 51112–Unit #12	611	711	811 81121–District "A" … 81122–District "B"	911
—12 Non-productive labor	512 51201– Unit #1 … 51202–etc.	612	712	812	912
—19 Fringe benefit wages	519 51901–etc. … 51902–etc.	619	719	819	919
-2 EQUIPMENT MAINTENANCE & REPAIRS					
—21 General	521 52101–Unit #1 … 52112–Unit #12	621	721	821	921
—22 Drawworks	522 52201–Unit #1 … 52202–etc.				
—23 Engines	523 52301–etc. … 52302–etc.				
—24 Wire line	524 52401–etc. … 52402–etc.				
-3 TRANSPORTATION EQUIPMENT EXPENSE					
—31 Maintenance, repairs & accessories —32 Gasoline & oil —33 Tires & tubes	Frequent assignment changes of pickups from one unit or use to another makes accumulation of costs chargeable to any one unit, job or department impractical. Where this practice prevails, costs per vehicle are accumulated by vehicle number & charged to the unit, job or department to which that vehicle is assigned at the end of the month or other accounting period.				
-4 MATERIALS & SUPPLIES					
—41 Expendable supplies	541 54101–Unit #1 … 54102–Unit #2	641	741	841	941
—42 Tool replacements	542 54201–Unit #1 … 54202–etc.	642	742		
—43 Fuel & lubricants	543 54301–etc. … 54302–etc.	643	743		
—44 Swab cups & oil saver rubbers	544 54401–etc. … 54402–etc.				
-5 HIRED SERVICES & EQUIPMENT RENTAL					
—51 Hauling & winch work	551 55101–Unit #1 … 55102–Unit #2				
—52 Misel. hired services	552 55201–Unit #1 … 55202–etc.			852	
—53 Equipment rental	553 55301–etc. … 55302–etc.			853	
-6 TRAVEL & CREW EXPENSE	560 56001–Unit #1 … 56030–Unit #30	660	760	860	960
-7 DEPRECIATION					
-8 INSURANCE					
—81 Fleet coverage	581 58101–Unit #1 … 58121–Unit #21	681	781	881	981
—82 Equipment damage coverage	582 58201–Unit #1 … 58230–Unit #30	682	782	882	982
—83 Public liability & property damage	583 58301–etc. … 58302–etc.	683	783	883	983
—84 Workmen's compensation	584 58401–etc. … 58402–etc.	684	784	884	984
—85 Group Hospitalization & keyman	585 58501–etc. … 58502–etc.	685	785	885	985
-9 MISCELLANEOUS EXPENSES					
—91 Misel. & general expenses	591	691	791	891	991
—99 Third party charges	599	699	799		
xxxx	xxxx	xxxx	xxxx	xxxx	xxxx

EXAMPLE OF EXPENSE GROUPING FOR:
PROFIT & LOSS STATEMENT
FUNCTIONAL ANALYSIS:
Well servicing operations
Maintenance Shop operations
RESPONSIBILITY ISOLATION:
Well servicing unit #1 xxx
Well servicing unit #2 xxx
Well servicing unit #30 xxx

in principle one single system can be adapted by everyone, if it embodies at least the precepts here summarized:

1. Founded in a set of sound, comprehensive source documents—*accurate, complete, timely* and *verifiable* business facts. Decide what information is needed and who can best supply it; instruct how, when, where and why it should be supplied; then insist on getting it.
2. *Flexible* in application but *rigid* in content. Gather all the information; process as much of it as your business can afford, or as little as you can get by with . . . but *have* it. If it isn't recorded, it can't become history.
3. Serving a dual purpose: Primarily a useful tool of management, secondarily a cataloging of facts to insure compliance with law and regulation.
4. Stated in common denominator dollars and cents for formal reports and in comparisons, but also in more meaningful units of measure that give rise to dollar figures . . . hours worked, number used; miles per gallon; feet per hour, etc., etc.

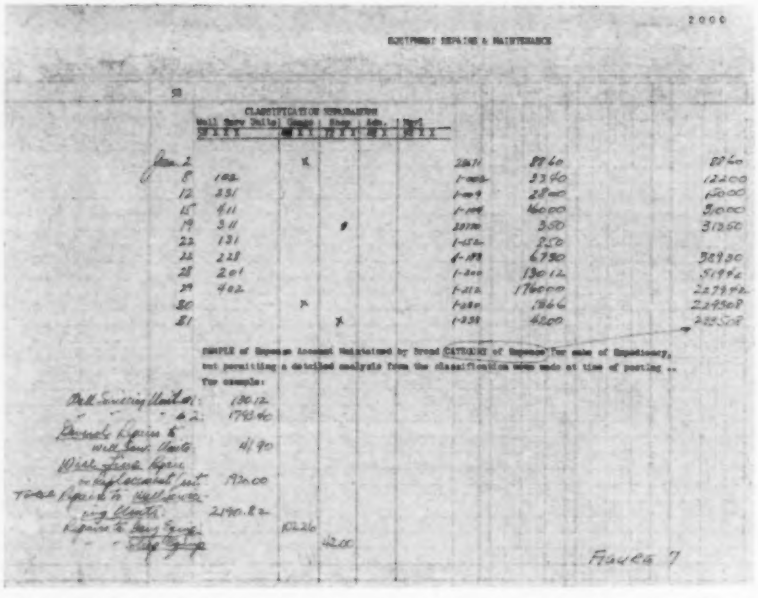


FIG. 7. **Detailed analysis** of equipment repairs and maintenance is possible using coding at the time of posting.

The Records

A specimen system-in-being is shown in Fig. 8 as regards documents and records used in collecting and processing payroll time. The payroll time ticket (P-1) is made in the field by the unit operator for himself and his crew at the end of the tour of duty. Time actually spent on location, for which the customer will be charged, is entered separately from non-productive time for which the employee is paid but which can not be charged to the customer, such as paying the driver of the pickup used to transport the crew and materials to and from the location.

Productive time for all employees working on a particular job during any one calendar day is entered on the field work order (or company time ticket) shown in Fig. 9 (document R-2). Payroll time and company time

FIG. 8. **Payroll information** flow from recording of time on the job to posting of labor charges, classified as to productive and non-productive, and by department or function to appropriate distribution ledger cards.

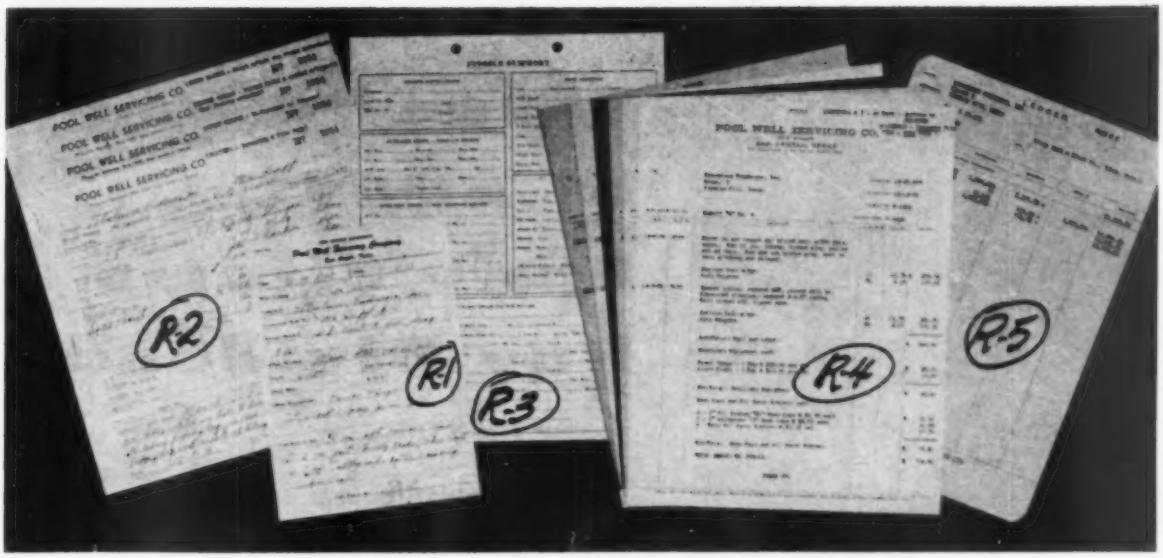


FIG. 9. **Source documents** pertaining to revenue accounting from time order (for work to be performed, R-1) is received until job "comes to rest" as an accounts receivable (R-5).

tickets are cross-referenced by showing the control number(s) of one type document on the other. Payroll time tickets for work performed on any day on a particular job are attached to a carbon copy of the field work order covering that day's work. After being checked and approved by the district foreman, payroll time is summarized on the daily personnel report (P-2) which lists each employee's time that day and the unit on which he worked, and his total accumulated time for the week, or indicates that he did not work that day, and why. All payroll time, with field work order copy to which pertaining attached, is mailed with the daily personnel report as a transmittal sheet.

Payroll Check

After verification of payroll time with productive labor time as shown on a copy of the field work order to which attached, the employee's time is posted to a combination payroll check-labor cost distribution sheet (P-3). The top portion of the original of this document becomes the employee's record of his earnings and deductions, gross pay to date, etc., and his pay check. The bottom portion is used as a labor cost distribution device by tearing at the perforations and sorting the detailed charges by hour of straight and overtime per unit per rate of pay for the various occupations that employee performed that particular pay period.

A carbon copy of the entire document from the top of the payroll check portion to the bottom is retained in numerical order as a permanent record of original entry. By carbon-strip and peg-board process, the summary of earnings by rate of pay per hour (depending on occupation) as computed at the very top of the form produces, as a by-product of employee earnings, deductions, and net pay determination, the employee earnings record card (P-4) and the payroll journal (P-5), which provides for a labor distribution of *straight-time* by function (or department) in the columns at the extreme right side, for workmen's compensation and public liability insurance premium computation.

As each employee's gross earnings to date are brought forward and made a matter of record for the employee and the contractor's payroll record each pay day, it is easy to determine how much, if any, of any employee's current wages are subject to state and federal unemployment contribution rates, and whose wages (or how much) are currently subject to Federal Old Age Benefit withholding from the employee and accrual by the contractor.

Control List

When the total payroll has been processed, verified and balanced, checks going to any particular district are entered on a control list (P-6) made in duplicate. The original accompanies the checks, and serves as a receipt form for delivery of paychecks to the proper employee who (or his wife) signs for his check opposite his name on the list, and indicates the date the check was received. The carbon copy of this form is retained in the accounting office until the signed original is received from the district to which originally sent with the paychecks thereon listed.

A separate ledger account (P-7) is kept to record labor costs for each unit; a control ledger account for total gross wages paid each pay period is likewise kept as a current and total-to-date control figure for all *labor*, regardless of function, department or other subclassification, against which gross wages on quarterly and annual reports to state and federal agencies can be checked.

Serving the Customer

When we have installed an accounting system that meets the needs of the contractor, the next step is to seek its application in serving the customer. It should be possible by using combinations of data from this system to determine positively what type mechanical procedures are most economical to the producer. Technical development in engine development, power transmission and new steel alloys permit the manufacture of improved equipment and enables the contractor to improve his methods and procedures. Without an accounting system which gives the dollar test to these developments, the contractor is either lost or simply following the course set by others in a herd-bound fashion.

The fact that an accounting system will serve both the customer and the contractor, regardless of what else it may do, is proof the means are justified in the end.

Acknowledgment

The mechanical procedures and descriptions presented are the work of Eric Behrend, business manager of Pool Well Servicing Company, whose efforts are gratefully acknowledged. ★

Servicing contractors' president points to . . .

Three Years of AOSC: Early Efforts Pay Dividends

Three-year-old group strengthens bonds to solve common problems

J. F. McAdams, *President,*
Association of Oil Well Servicing Contractors

LITTLE LESS THAN THREE YEARS AGO, January 26, 1956, to be exact, 13 men met in the Permian Basin city of Odessa, Texas, and took a large and hazardous step. They decided to take the initiative in the formation of a trade association, to be called the Association of Oil Well Servicing Contractors.

By way of background facts, let us remember that it had been only a scant dozen years before that well servicing on the basis of independent contracts had been accepted generally by the oil industry. When this happened, the well servicing industry attempted to "spring full grown from the forehead of Zeus," and like any young burgeoning industry, it developed growing pains. The business of well servicing was in many instances not a business at all, but a haphazard operation resulting in poor service to the producer and, based on gross earnings, insufficient profits to the contractors.

The founders of the association saw clearly in current oil developments that an era of retrenchment was near at hand. Foreign oil, low allowables, and tax problems were taking lots of former profits out of the pockets of producers, and tremendously increased competition was doing the same in the case of well servicing contractors. These men, projecting their thoughts to the future, saw that only through organization could well servicing increase its service, improve its efficiency, and thus survive. There is and will be, no place in the modern oil industry for haphazard operations. Oil is no longer a boom-and-bust, high-margin-of-profit industry, and those who serve producers must meet the changing times.

Association By-Laws

Accordingly, the founders of the association risked their funds and their efforts, to form a non-profit Texas corporation. The by-laws of the association state the following:

SECTION 1. To organize an association of oil well servicing contractors to acquire, preserve and disseminate valuable business information and generally to promote the interest of oil well servicing contractors to the general public.

SECTION 2. In order to carry out the purpose of the Association, the Association shall endeavor:

(a) To make membership in the Association a reasonable assurance to the public of the skill, integrity and responsibility of its members.

(b) To maintain high standards of workmanship and to establish members of the Association in the public mind as contractors who fulfill obligations in good faith.

(c) To promote more cordial and cooperative relations among oil well servicing contractors and between oil well servicing contractors and those with whom they deal or have contact.

(d) To encourage efficiency among oil well servicing contractors and their employees.

(e) To seek correction of injurious, discriminatory or unfair business methods practiced by or against oil well servicing contractors.

(f) To eliminate, as far as possible, the occurrence of injury and death to oil well servicing contractors' employees.

Since its formation, officially February 27, 1956, the AOSC has expanded. It has increased its membership from 13 to 273, and has now 17 chapters embracing a membership from eight states. States now covered are New Mexico, part of Colorado, Texas, Oklahoma, Kansas, Louisiana, Arkansas, and Mississippi.

Rapid Growth

Our growth, and we call ourselves the fastest growing association in the oil industry, is due in large part to our associate members. Some 30 manufacturers and suppliers have come into the association as associate members, and have been a moving force in its growth. They recognized, perhaps, even before the contractors themselves, that the aims and purposes of the group as formed would make well servicing a stronger facet of the industry, which in turn will be good for them. As a result, their support and diligent efforts have done much to make the association grow. They attend our meetings, both local and national, and a special associates advisory committee has worked with our board in matters where associates were affected.

We offer the associates certain advantages, also. They have in our organization a selective group all of whom are prospective customers. They can work closely with us, without feeling that they may be overselling their

products, and above all, we feel that we are dealing with friends. They have, through associate membership, an opportunity to obtain a closer and friendlier connection with their customers.

Many outstanding manufacturers and suppliers have not yet been included in our associate membership. As we come to know them better we hope they will come with us, and assist us in the achieving of our aims and purposes.

Contractors' Problems

Our problems are very wide in scope. We feel that basically any group containing small, large, and middle sized operations — to say nothing of a group which contains members who service all type of oil wells, with the enormous variances of depth, location, and formation — is going to have diversified problems. The problems of the shallow well servicing contractor cannot be the same as that of the offshore operation or the deep hole contractor. Many problems may be unique in a single area or a single state. Therefore we have attempted to leave local autonomy in our chapters, letting the local chapter deal with the local problem. We, as a national association, have tried to select the problems most universal in well servicing, and these are the ones we use as a guide in adopting projects for our permanent staff to work on. We feel that we have achieved a large thing in our new insurance program. This program, adopted at our last board of directors' meeting, will in my opinion, create a sizable saving in well servicing. Of course this is limited to our membership.

Other projects are being pushed at this time; a unified system of cost accounting, needed legislation, and safety are three of our more important projects. If our unity and growth continue, if the membership of our group continues, as in the past, to support the association, we will go on and up. I am firmly convinced that if the independent well servicing contractor is to continue as an oil field species, today's demand for greater mobility of equipment must be met, together with the demands for more modern and bigger equipment. I believe a higher standard of skill in the men who work for the contractors must be achieved. I believe that more supervision is necessary, so that the company man will not feel compelled to act as supervisor without portfolio. I see in the future a unified program to train men before letting them work in the field on a servicing unit. And I believe that the only way to accomplish the unity necessary for the accomplishment of these improvements is through our membership. In short, I am firmly convinced that the subindustry of well servicing, its growth and well being, is dependent in great degree upon the growth and continued dynamic activity of the Association of Oil Well Servicing Contractors. ★ ★ ★

AOSC adopts a . . .

New Insurance Program for Oil Well Servicing Contractors

James E. Danheim, *Executive Secretary, Association of Oil Well Servicing Contractors*

ON October 8, 1958, the Association of Oil Well Servicing Contractors, acting through its board of directors, adopted a far-reaching insurance proposal which is expected to effect an insurance saving for its members in all eight states from which its membership is drawn.

The program is a rather complicated one and is basically in three major divisions. These are: (1) workmen's compensation; (2) general public liability of all types; (3) general risk or physical damage insurance.

These divisions are further broken down into eight subdivisions of each, according to the slight variance in state laws of the eight states represented in the association's membership.

Basically, the proposal works like a woman's shopping bag, in that it is a composite of insurance bargains. This is necessary, because the cost of insurance has been the contractor's third largest item of cost and the second largest operating expense. The largest item is his capital outlay for equipment, the second largest is the payroll, and then the insurance cost. Too often the contractor has been in the position of paying an insurance penalty instead of insurance premiums.

By and large, the experience of the

James E. Danheim

membership of the AOSC has been better then the industry average. They feel that the basic rates on their operation is and has been out of line on the basis of their experience. They have long sought to obtain their insurance on a cost basis. The new association proposal is a well thought out attempt to procure for the contractor full coverage at cost.

The program, now ready to become operational in Oklahoma, is, as to workmen's compensation coverage, based on self-insurance laws. Texas and Colorado have such stringent laws regarding self-insurance that it will not be offered in these two states immediately.

Self-insurance has long been considered the only manner in which the individual can obtain insurance at exact cost. The drawback to self-insuring on an individual basis has been the fact that re-insurance for the individual is excessively expensive. By combining the membership of the association, re-insurance will be acquired at a reasonable rate. It is anticipated that the program will achieve a saving of 20 percent for the average contractor.

The savings hoped for under the program in the field of public liability insurance will of necessity be due to experience variations and the coverage of large numbers. Experience is presently being acquired from the membership and details of its administration are not fully available at this time. Savings on physical damage insurance will depend on coverage of a large number of contractors through a company; a modified group policy will be provided.

Administration of the entire program will be by a management company located in Oklahoma City. Membership in the AOSC is a requirement for participation in the program.

★ ★ ★

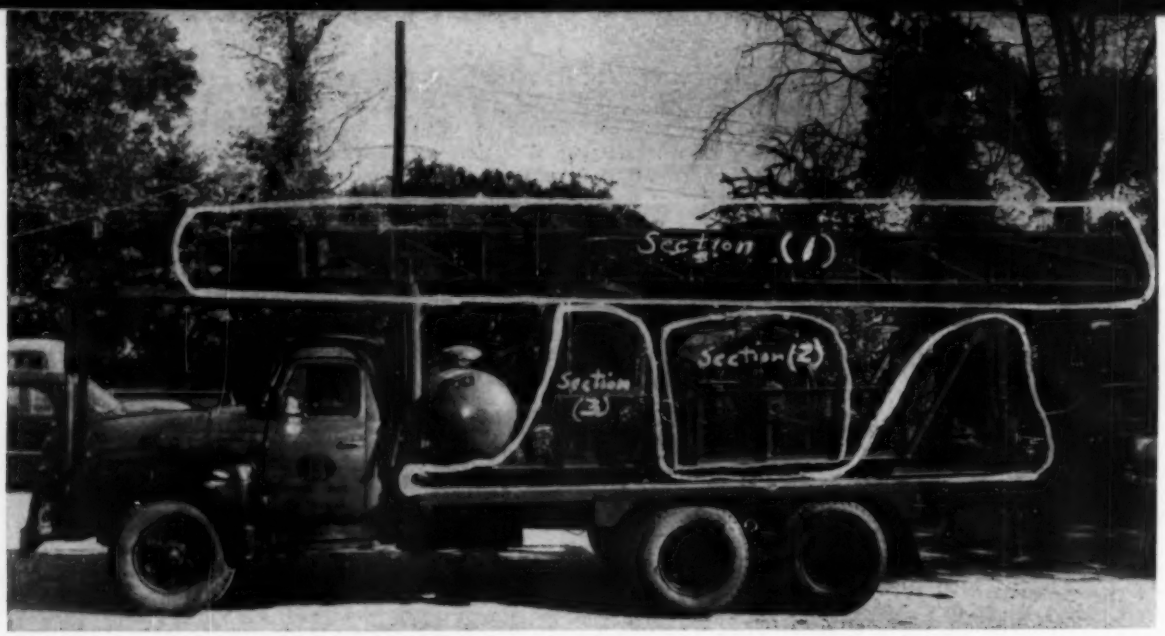


Fig. 1 shows the totally skid-mounted swabbing unit loaded on a truck and ready to travel to either a barge landing for servicing an offshore well, or, to service a well onshore from its truck base.

Efficient and mobile, this . . .

Specialized Well Servicing Equipment . . .

for offshore and inland marine waters was designed and built by a South Louisiana contractor. Oil operators are saving money and time

Jerry E. Shea
Bayou Well Works, Inc.
New Iberia, Louisiana

TO COVER the well servicing field in South Louisiana, this company must operate on the tempestuous waters of the Gulf of Mexico; on often storm-tossed waters of lakes and inland waterways; and on marsh, and sometimes dry land. After several years of intensive planning and experimenting three types of servicing units, each with its own special features, have been successfully developed and operated.

Basic motivating forces responsible for the development of this equipment was the desire to be able to service any well in this area faster, more safely and dependably for the benefit of all concerned. These units have swabbed, bailed sand and fished for tools down to a depth of 14,000 ft. Described first is the unit developed for offshore operation.

Any offshore operation is expensive and swabbing in a dead offshore well is no exception. Innovations to lower these costs are of high interest to offshore operators. The main objectives in the design of the offshore unit was to build a "sectionalized" swabbing unit that could be easily loaded and unloaded from barge to platform and vice versa, without the use of special and expensive handling equipment.

Using conventional components, this company has developed a complete swabbing unit that can be quickly disassembled into three packages weighing less than 5000 lb each. Fig. 1 shows how the unit is divided for this purpose. Fig. 2 shows the unit mounted on a truck and ready to travel. Fig. 3 shows the unit set up on land where it can also be used.

All the rig components are mounted on a skid assembly. As shown in Fig. 1, the first section to be removed in the disassembly process is the mast. This is accomplished by pulling two tapered pins. Section 2, the hoist assembly, is removed next by unbolting from the skid assembly. The remaining section 3 is composed of the skid assembly and the engine for operation of the hoist.

The diesel engine is equipped with a hydraulic starting motor which eliminates the battery, generator, voltage regulator, ampmeter and the wiring for this equipment. The electric starting motor is replaced by a hydraulic starting motor. This system is excellent for offshore operation where corrosion is severe on electrical components. Other important features make it explosion proof, dependable and adjustable for a wide range of cranking speeds.

Most offshore platforms are permanently equipped with a crane boom capable of handling small loads and this is why each swabbing unit section weighs less than 5000 lb. The expense of providing a larger capacity crane would cost the operator much more than the cost of the entire swabbing operation.

Other important features are the overall dimensions and total weight of this unit. The mast was specially designed to be within the length limit set by state highway regulations. The width, height and weight limit set by the regulations were also observed; being able to travel the state highways without a permit can be of definite advantage.

Upon receiving a call to swab an offshore well, the contractor starts a unit

The author is vice president of Bayou Well Works, Inc. and a 1949 petroleum engineering graduate of Louisiana State University.

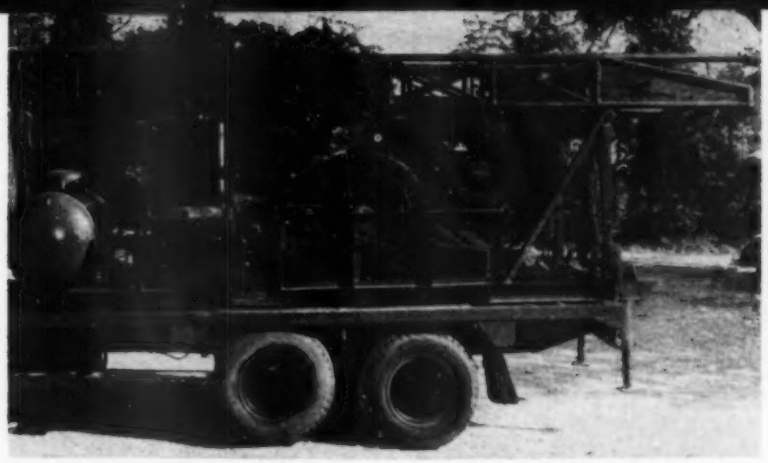


Fig. 2 is a close-up view of offshore unit ready to travel state highways without permit.

on the road early enough to arrive at the barge landing before daybreak, or at any time specified by the customer. Swabbing operations on any of the company's units are handled by a two-man crew.

Upon arrival at the the barge landing, the unit is disassembled and loaded on the operator's barge or boat by sections and transported to the offshore platform. At the platform, the three swabbing unit sections are unloaded from the barge by the small platform crane. The sections are then quickly reassembled to make up the complete swabbing unit ready for operation. The unit is moved into position by using its own hoist, then the mast is raised, rigging completed and swabbing operations begun.

Whatever blowout equipment required by the operator is installed and fully checked for safe operation. The servicing contractor usually furnishes a lubricator made from 3-in. hydraulic tubing approximately 26 ft long. He also furnishes a 10,000 lb test lubricator tool trap to use on the bottom of the lubricator and a 2500-lb test line wiper for the top. The line wiper is equipped with a universal joint and extension so that it may be operated from the floor.

In summary then, this "sectionalized" unit has these advantages:

1. The unit can be disassembled into three sections, each weighing less than 5000 lb. Most cranes kept permanently on the offshore platforms can handle this size load. Using existing facilities saves the operator the cost of contracting a large barge-mounted crane.
2. By sizing the unit to be within state highway regulations, travel is permitted at night or on the week-ends so that important time is saved by both the contractor and the operator, as well as the

Fig. 3 shows the unit set-up ready to service an onshore well. Height of mast is 48 ft and line capacity of the hoist is 12,000 ft of 9/16 in. line.

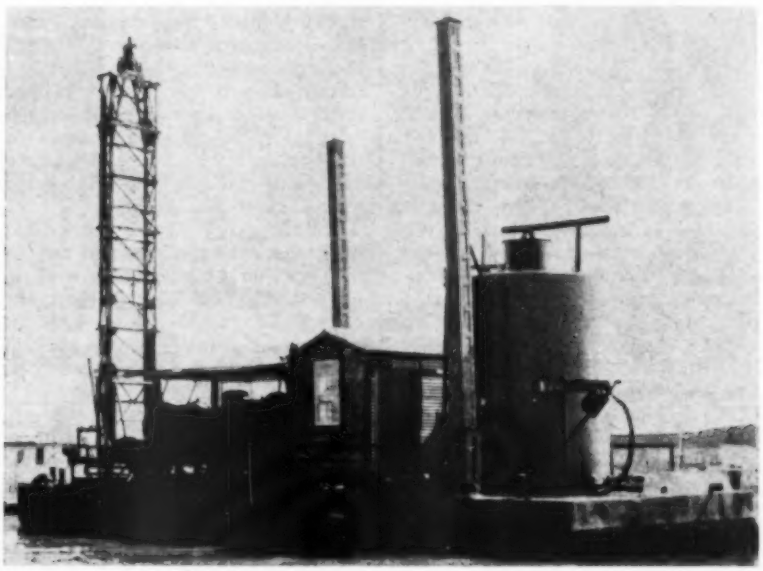


Fig. 4 Side view of the special barge developed for servicing wells located on inland marine waters. The two steel columns on each side are spuds to keep the barge in place. The large tank at the rear is used to swab into while testing.

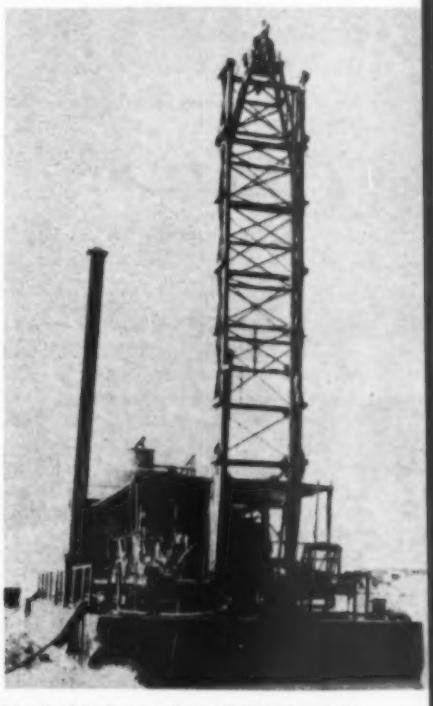


Fig. 5 This front view of the barge for inland marine water well servicing shows how the barge is fitted to move in close to the well head.

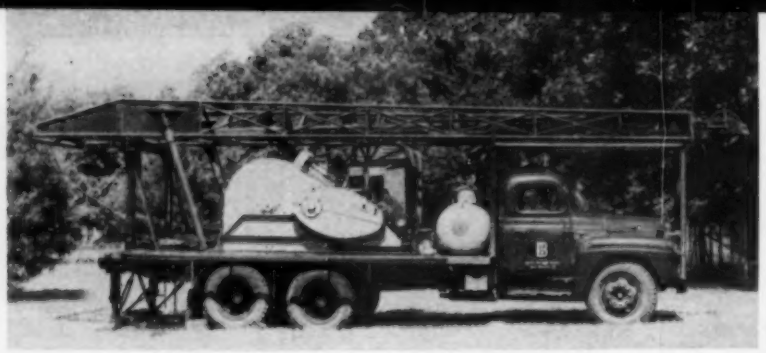


Fig. 6 This is the third series of well servicing units developed by this contractor. Again, using conventional components but its own special mast, this view shows the unit in position ready for the mast to be raised.

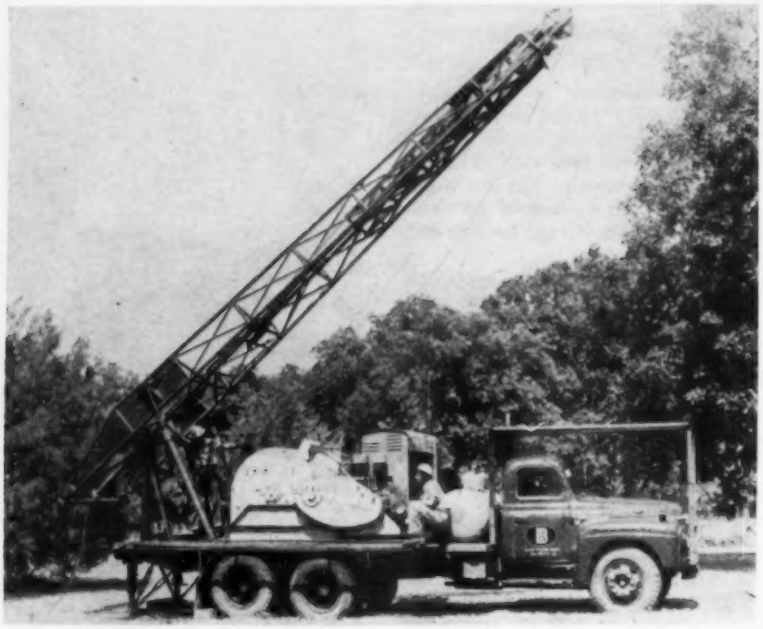


Fig. 7 View showing the hydraulic rams raising the mast into position with the full crew aboard.

Fig. 8 Mast in its working position. Note the special ram mounted in the center of the mast to telescope out the mast to its full height. The unit is shown completely rigged with the lubricator hanging ready to be connected to the well head.

cost of permits. Almost any schedule required by the operator can be met.

3. The unit can also be used truck mounted for inland marine or onshore operation.

Pictured in Fig. 4 is the barge unit developed for servicing wells located on inland marine waters of this area. All well servicing equipment is permanently installed on the barge.

The barge itself is 6-ft deep, 24-ft wide and 70-ft long. It is not self-propelled and requires the customer's tug to move it to location. A 53-ft structural mast is raised by cable and the hoist drum has 9/16-in. line capacity of 15,000 ft.

Immediately behind the diesel engine a double-drum hoist is installed which raises the two 12-in. by 12-in. by 30-ft long spuds. After the barge is lined up with the well head, the two spuds are lowered to prevent any movement of the barge. This feature is especially important when wind and waves are high; the two spuds are located to achieve maximum stability for these conditions.

At the rear of the barge is a 150-bbl gunbarrel tank which is used to swab into and for testing the well after it starts flowing. The tank is equipped with an automatic syphon arrangement. As the tank is filled, a small pump is used to fill a forward compartment of the barge to keep the barge level. This same pump is used to pump oil from this tank to field storage tanks after swabbing and testing are completed.

Other equipment on the barge includes two 560-gal storage tanks; one for diesel fuel and the other for fresh water. The bunk house has two bunks and two-way radio equipment is installed here. Fire fighting equipment is also carried aboard. The same type lubricator and safety valves are used as described for the offshore unit and can be seen in Fig. 5, alongside one leg of the mast.

A third type unit, truck mounted, was also developed for onland well servicing. It uses the same special telescopic structural mast developed for the other previously described units, except that it is now raised into position by means of a special hydraulic system. Fig. 6 shows this unit ready for the mast to be raised. Fig. 7 shows the mast being raised and Fig. 8 shows the mast in the raised position.

Note the small hydraulic ram located in the center of the mast and used to telescope out the mast to its working position. The hoist has a 9/16-in. line capacity of 14,000 ft, and wells located on inland marine waters can also be serviced with this unit by using the customer's barge.

This company has been well pleased with operation of all three of these units of its own design. It has benefited materially from their special features which provide a specialized rig for servicing any type well in this area. In an area where such a wide latitude of difficult land and water conditions exist, this is a noteworthy accomplishment. ★ ★ ★

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If thoroughly studied and well planned . . .

Well Workovers Will Pay Big Dividends

See how Sun Oil Company beats the averages in this rough "game of chance" to make it one of its most profitable operations

Raoul Bethancourt
Sun Oil Company,
Dallas, Texas

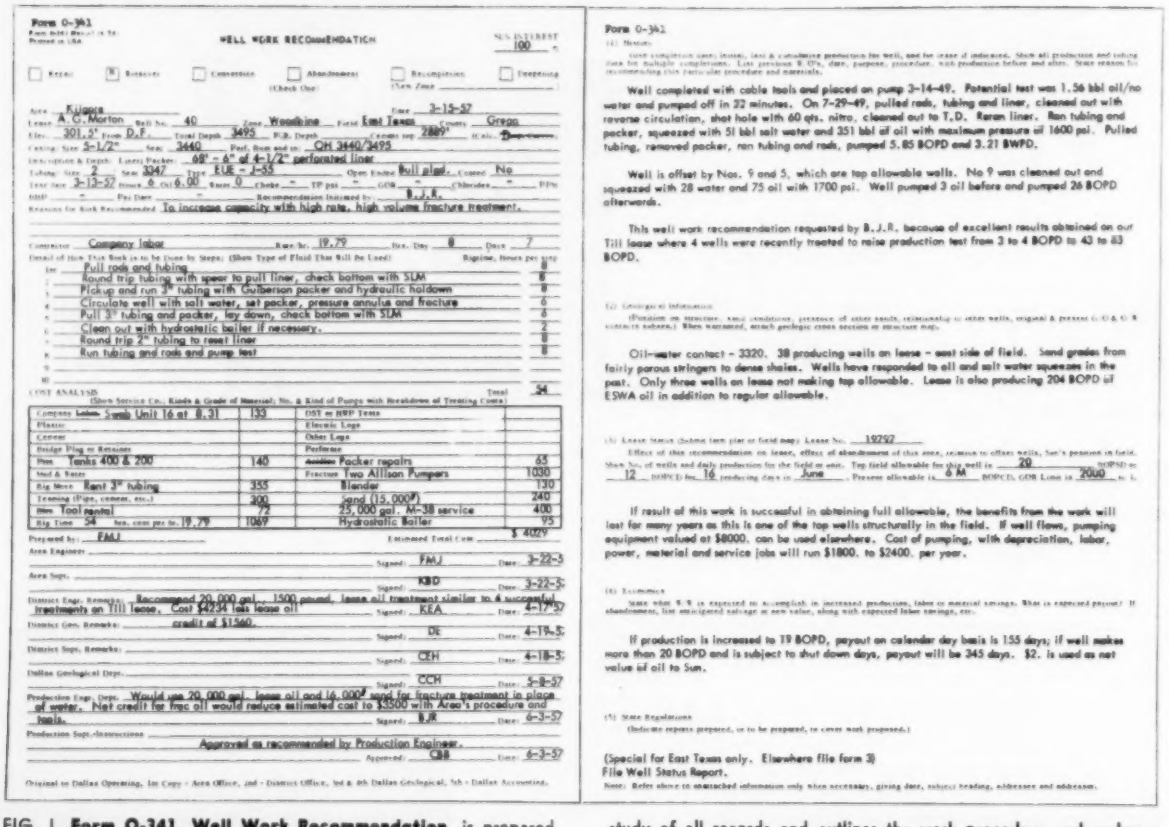
THE RESULTS OF WELL WORK are often unpredictable and costly. A complete and thorough study of the well, the area and other related factors can materially assist in determining beforehand if the prospective work warrants consideration. The study can result in work with a reasonable certainty of results that will be profitable to the operator.

This article shows how a large company, like Sun Oil, has systemized its handling of workover requests to take full advantage of a wide range of the company's talent in every field affected by a workover expenditure.

An important aid to all personnel dealing with workover requests is the excellent system of communicating well organized and complete information on workover requests. By means of standard company forms that have been developed over a period of years, all information required by the various departments is clearly outlined and obtained before the workover request leaves the area office, or the point of initiation.

Company forms are extended to include summary data on well work all over the division. This summary information is continually studied for useful trends and conclusions that will help each area to be more successful in its well work operations.

Proof that this system works and pays big dividends is shown by the consistent lowering of the payout period for the average workover project. For example, in recent years the average payout was just slightly over one-half year; more recently, it has been reduced to substantially less than one-half year. Not all years show that much reduction, and in 1958 it will probably be higher because of severe reduction of allowables, crude price cuts and other similar circumstances which adversely affect normal operating conditions.



Form O-341

WELL WORK RECOMMENDATION

SUN INTEREST 100 %

☐ Repair ☒ Recomplete ☐ Conversion ☐ Abandonment ☐ Recompletion ☐ Deepening (Check One)

Area Kilgore Date 3-15-57
Lease A. C. Morton Well No. 40 Zone Woodbine Field East Texas County Gregg
Elev. 301.5' From D.F. Total Depth 3495 P.B. Depth 3280' Casing: Size 5-1/2" Set 3440 Perf. from and to OH 3440/3495
Description & Depth: Liner, Packer: 68" - 6" of 4-1/2" perforated liner
Tubing: Size 2 Set 3247 Type EUE - J-55 Open Ended Pull plgd. Connec. No
Last Test 3-13-57 Hours 6 Oil 6.00 Water 0 Choke " TP psi " GOR " Chlorides " PPM
IHP " Pay Date " Recommendation Initiated by B.J.R.
Reasons for Work Recommended To increase capacity with high rate, high volume fracture treatment.

Contractor Company labor Rate hr. 19.79 Est. Day 8 Days 7
Detail of How This Work is to be Done by Steps: (Show Type of Fluid That Will Be Used) Regime, Hours per step

1. Pull rods and tubing 8
2. Round trip tubing with spear to pull liner, check bottom with SLM 8
3. Pickup and run 3" tubing with Guiberson packer and hydraulic holdown 8
4. Circulate well with salt water, set packer, pressure annulus and fracture 6
5. Pull 3" tubing and packer, lay down, check bottom with SLM 6
6. Clean out with hydrostatic bailer if necessary. 2
7. Round trip 2" tubing to reset liner 8
8. Run tubing and rods and pump test 8
9.
10.
Total 54

COST ANALYSIS (Show Service Co., Kinds & Grade of Material, No. & Kind of Pumps with Breakdown of Treating Costs)

Company Labor Swab Unit 16 at 8.31	133	DST or HPP Tests	
Pharco		Electric Logs	
Cement		Other Logs	
Bridge Plug or Retainer		Perforate	
Pipe Tanks 400 & 200	140	Packer repairs	65
Mud & Water		Fracture Two Allison Pumpers	1030
Rig Work Rent 3" tubing	355	Blender	130
Trucking (Pipe, cement, etc.)	300	sand (15,000#)	240
Hire Tool rental	72	25,000 gal. M-38 service	400
Rig Time 54 hrs. cost per hr. 19.79	1069	Hydrostatic Bailer	95
Prepared by: FMJ		Estimated Total Cost	$ 4029

Area Engineer Signed: FMJ Date: 3-22-57
Area Supt. Signed: KBD Date: 3-22-57
District Engr. Remarks: Recommend 20,000 gal., 1500 pound, lease oil treatment similar to 4 successful treatments on Till lease. Cost $4234 less lease oil credit of $1560. Signed: KEA Date: 4-17-57
District Gen. Remarks: Signed: DE Date: 4-19-57
District Supt. Remarks: Signed: CEH Date: 4-18-57
Dallas Geological Dept. Signed: CCH Date: 5-8-57
Production Engr. Dept. Would use 20,000 gal. lease oil and 16,000# sand for fracture treatment in place of water. Net credit for frac oil would reduce estimated cost to $3500 with Area's procedure and tools. Signed: B.J.R Date: 6-3-57
Production Supt.-Instructions Approval as recommended by Production Engineer. Approved: CEH Date: 6-3-57

Original to Dallas Operating, 1st Copy - Area Office, 2nd - District Office, 3rd & 4th Dallas Geological, 5th - Dallas Accounting.

Form O-341

(1) Reason
(Give complete data: history, test & cumulative production for well, and for lease if indicated. Show all production and tubing data for multiple completions. List previous W.O's, date, purpose, procedure, and production before and after. State reason for recommending this particular procedure and materials.

Well completed with cable tools and placed on pump 3-14-49. Potential test was 1.56 bbl oil/no water and pumped off in 32 minutes. On 7-29-49, pulled rods, tubing and liner, cleaned out with reverse circulation, shot hole with 60 qts. nitro, cleaned out to T.D. Reran liner. Ran tubing and packer, squeezed with 51 bbl salt water and 351 bbl oil with maximum pressure of 1600 psi. Pulled tubing, removed packer, ran tubing and rods, pumped 5.85 BOPD and 3.21 BWPD.

Well is offset by Nos. 9 and 5, which are top allowable wells. No 9 was cleaned out and squeezed with 28 water and 75 oil with 1700 psi. Well pumped 3 oil before and pumped 26 BOPD afterwards.

This well work recommendation requested by B.J.R. because of excellent results obtained on our Till lease where 4 wells were recently treated to raise production test from 3 to 4 BOPD to 43 to 83 BOPD.

(2) Geological Information
(Pressure on structure, sand conditions, presence of other sands, relationship to other wells, original & present G/O & O/W contacts subsea.) When warranted, attach geologic cross section or structure map.

Oil-water contact - 3320. 38 producing wells on lease - east side of field. Sand grades from fairly porous stringers to dense shales. Wells have responded to oil and salt water squeezes in the past. Only three wells on lease not making top allowable. Lease is also producing 204 BOPD of ESWA oil in addition to regular allowable.

(3) Lease Status (Submit tank plan or field map) Lease No. 19297
Effect of this recommendation on lease, effect of abandonment of this zone, reversion to offset wells, Sun's position in field. Show No. of wells and daily production for the field or unit. Top field allowable for this well is 20 BOPD or 12 BOPD/Ac. for 16 producing days in June. Present allowable is 6 M BOPD, GOR Limit is 2000 to 1.

If result of this work is successful in obtaining full allowable, the benefits from the work will last for many years as this is one of the top wells structurally in the field. If well flows, pumping equipment valued at $8000. can be used elsewhere. Cost of pumping, with depreciation, labor, power, material and service jobs will run $1800. to $2400. per year.

(4) Economics
State what W.O. is expected to accomplish in increased production, labor or material savings. What is expected payout? If abandonment, list anticipated salvage or new value, along with expected labor savings, etc.

If production is increased to 19 BOPD, payout on calender day basis is 155 days; if well makes more than 20 BOPD and is subject to shut down days, payout will be 345 days. $2. is used as net value of oil to Sun.

(5) State Regulations
(Indicate reports prepared, or to be prepared, to cover work proposed.)

(Special for East Texas only. Elsewhere file form 3)
File Well Status Report.
Note: Refer above to attached information only when necessary, giving date, subject heading, addressee and addresser.

FIG. 1. **Form O-341, Well Work Recommendation,** is prepared in the company area and is designed to present all data having to do with the proposed work. Completion of the form requires thorough study of all records and outlines the work procedure and makes a reasonable estimate of cost.

Workovers—A Game of Chance

Well work, by its very nature, is a game of chance. It, too, has its "long shots" and "sure things." The "long shots" sometimes come in and the "sure things" frequently fail. In many instances it may have been the lack of a thorough study of the workover that resulted in unsatisfactory results.

A systematic procedure of handling well work recommendations will improve the ratio of successful jobs. Workovers are different from original completion techniques in that the operator has a better performance history of the well and the reservoir. In addition, time works in his favor and not against him. He is not faced with the hourly need to do something, whether it be right or wrong, just because an expensive drilling rig is on location.

The results of well work in the Dallas division of Sun Oil Company have been very gratifying as this is probably one of the fastest returns on investment for large expenditures. Follow through this interesting story of how well work is handled in the Dallas division.

The Sun Organization

The Dallas division of Sun Oil Company is one of five producing divisions in the United States and two wholly owned companies engaged in foreign operations. The units are more or less independent of each other, pay their own bills, have their own accounting systems and departments.

The Dallas division, in turn, is divided into 2 regions, 6 districts and 19 areas. Each of these segments has a superintendent who is directly responsible to his supervisor for his segment. Each district and area, but not region, has an engineer (or staff of engineers) who is responsible for the engineering work in the segment. The engineer is responsible primarily to his superintendent, and also reports directly to the chief division engineer.

The Dallas division operates 4115 wells in parts of Texas, Oklahoma, New Mexico, Louisiana, Arkansas, and Mississippi. The large geographical size of the division, the large number of wells and the varied rules of the separate state regulatory bodies make it a difficult problem to obtain top production from each well and at the same time, produce at the lowest possible lifting cost.

Well Classification

Sun Oil divides workover wells into three general classifications: oil, gas, and project wells. Project wells include all wells used in pressure maintenance, with water or gas, water disposal wells, water supply wells and wells used for injection of gas in a cycling program.

Well work, by the definition peculiar to the Dallas division, includes all work performed after a well's original completion. This does not include normal servicing work unless some unusual feature such as an offshore or inland water location, or working with high pressures make it very expensive or hazardous.

Well work, in turn, is divided into six specific categories: (1) Deepening to a new zone, (2) recompletion in an upper zone of a cased hole, (3) conversion to project well, (4) workover (reperforate, shut off water or gas, deepen in same zone, stimulate by acid, fracture or surfactant treatments,) (5) repair and/or hazardous or expensive service jobs, and (6) abandonment.

Initiation of Recommendation

Theoretically, a request for a well work recommendation may be initiated at any level, by any departmental personnel. In practice, most of the well work recommendations are originated by the area engineers who are responsible for the preparation of the well work form. This is proper, as he, his area superintendent and foremen are most familiar with the day-to-day problem of producing the well and with the peculiarities of the particular reservoir in that area. About 25 percent of the well work recommendations are requested by the reservoir, land, geological or operating sections. Well files are always kept in the area, district and division offices in order to prevent loss because of fire or from other causes. The area files are usually much more complete and detailed.

Value of Company Forms

The well work form (0-341) (see Fig. 1) is always prepared in the area regardless of who might initiate the recommendation. The primary purpose of this form is to aid the person preparing the form to present all the data available to him that have a bearing on the recommendation for the proposed work. This insures a thorough study of the available records before the form can be completed. It also outlines exactly how the mechanics of the work are to be carried out and assists in making a cost estimate.

Pertinent information is always set out in some place where it can readily be found. (Pertinent information, by definition, is something which the reviewer thinks is important and cannot find on the form!) This provides an easy method for subsequent reviewers to detect errors or omissions. It also provides an opportunity to improve the recommended procedure by eliminating unnecessary steps, unduly complicated or hazardous procedures, all of which aid in holding costs to a minimum.

Estimated Costs

The working hours of the contract rig are very important, and careful planning can reduce rig costs. Usually, preference is given to units that work days because of the safety factor and the advantage of using down time for waiting on cement, running logs, perforating or setting plastic. It also gives field engineers and geologists an opportunity to review the day's work and, if necessary, consult with their office prior to proceeding.

The cost estimates are made in detail showing the service company to be used, tools, pumps, and material. This prevents misunderstanding, insures use of newest and best tools in a satisfactory manner and at minimum costs. In fracture treatments, it helps to anticipate the predicted rate and pressure, and compare it with the hydraulic horsepower available and what the cost will be.

Handling at Divisional Level

After the well work recommendation is received in the division office, it is reviewed by the production engi-

The Author

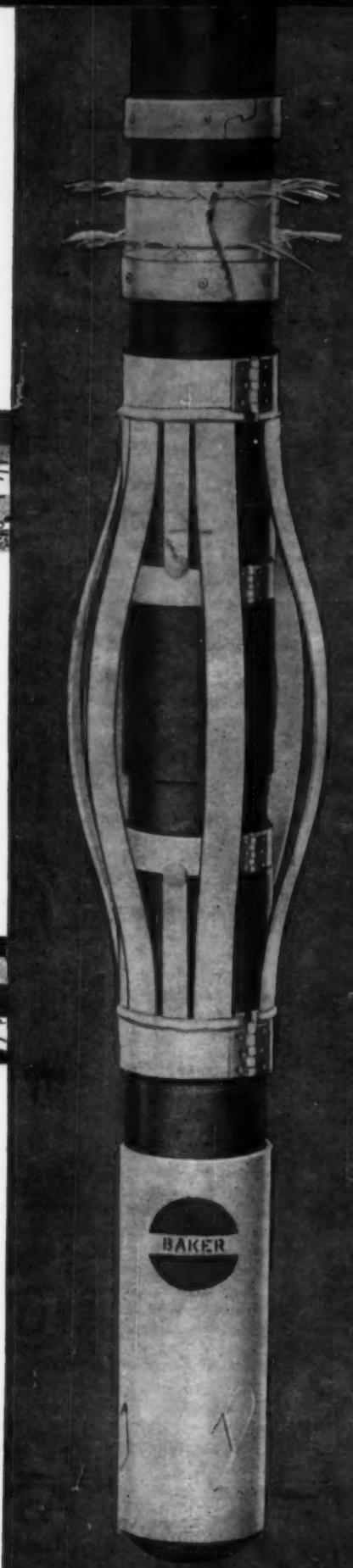
Raoul Bethancourt *is a petroleum production engineer in the Dallas division of Sun Oil Company. He was born in southern Louisiana and studied electrical engineering at A&M College of Texas. He joined Texas Power & Light Company as a design engineer in 1935 and later was employed by Sun Oil Company in 1937 in Kilgore, Texas. He has been with Sun Oil Company since that time, except for two and one-half years when the East Texas Saltwater Disposal Company was under organization. He has served in various engineering capacities with Sun in East and South Texas prior to his transfer to the division office in Dallas, Texas, in 1951. He is chairman of the Perforating Investigation Committee. He is a member of the API and is a member of four subcommittees on production practices. He is also a member of the AIME and has served as chairman of the Southwest Texas Section in 1949, as chairman of the Dallas Section in 1957 and is currently a director of the Society of Petroleum Engineers of AIME.*

IF YOU WANT MORE* THAN A GOOD CEMENT JOB..

* *Casing on Bottom Safer and Faster*

* *Protection of Productivity*

...Specify *BAKER* PRIMARY CEMENTING EQUIPMENT



Baker Wall Scratchers

HINGE-LOK or SOLID-RING Models for all popular casing sizes.

Baker Casing Centralizers

HINGE-LOK or SOLID-RING Models with Multiple Ranges for all popular casing sizes.

Baker Fill-Up Equipment

DIFFERENTIAL Shoes and Collars for *any* well, and economical FLEXIFLOW Shoes and Collars for wells of *moderate* depth

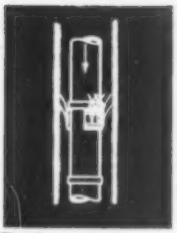


Fig. A

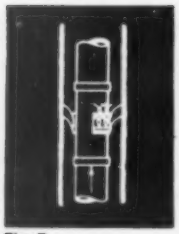


Fig. B

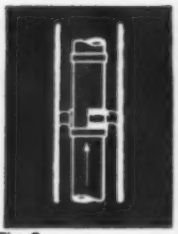


Fig. C

Fig. A Scratcher wires, retained by integral hinged mounting, swing freely upward and do not remove mud cake while running in.

Fig. B Even when casing is lifted out of the slips, the entire Scratcher remains stationary. Only when reciprocated, and

Fig. C ...only at the cementing area does the "scissors" action of the crossed wires remove mud cake.

Baker Scratchers remove mud cake only from the cementing area; this "controlled scratching" protects productivity.

While running in, the scratcher wires automatically swing upward along the casing, where they are safe from damage; permit free, unrestricted lowering of the casing; and do not disturb or remove mud cake. There is no danger of "balled-up" mud collecting on the scratcher wires to plug the annulus and contribute to pressure surges with possible "mudding-off" of the producing zone. Only when the cementing area is reached and the casing is reciprocated do the double rows of strong "crossed" spring wires automatically reach out, dig in, and remove the mud cake with efficient "scissors" action.

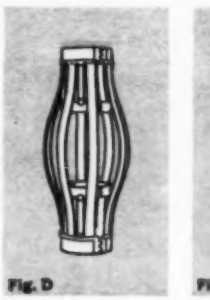


Fig. D

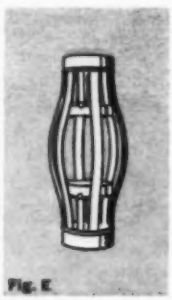


Fig. E

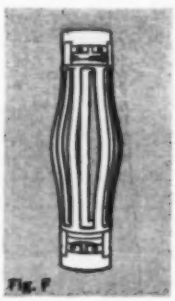


Fig. F

Fig. D "Extended" Range HINGE-LOK Baker H-25 Casing Centralizer Product No. 9113.

Fig. E "Normal" Range HINGE-LOK Baker H-20 Casing Centralizer Product No. 9112.

Fig. F "Slim Hole" SOLID-RING Baker G-15 Casing Centralizer Product No. 910-G.

Baker Centralizers assure cementing clearance. "No-scrape" design prevents "balling", plugged annulus and stuck casing.

The QUALITY of Baker Casing Centralizers starts with "sled-runner" springs made of high quality spring steel – tested and pre-set by flattening in hydraulic presses – then butt-welded to collars to form a unit of great strength. Pre-setting of the springs to the pre-calculated optimum bowed height enables each centralizer to pass tight spots or dog legs without damage to the assembly, and ensures GREATER CENTERING FORCE for maintaining annular clearance for cementing.

Baker Centralizers do not remove mud cake which could plug the annulus, contribute to pressure surges and restrict productivity.

BAKER OIL TOOLS, INC.

Houston · Los Angeles · New York

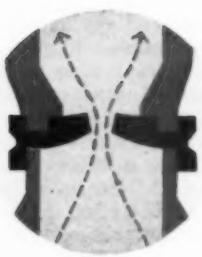


Fig. G

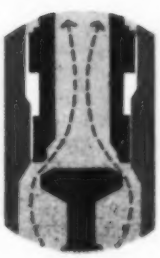


Fig. H

Fig. G Variable FILL-UP Valve as used in FLEXIFLOW Equipment.

Fig. H Variable FILL-UP Valve as used in DIFFERENTIAL Equipment.

Baker Fill-Up Equipment saves time in running casing, but does not create pressure surges that reduce productivity.

Destructive pressure surges – often created when casing equipped with conventional floating equipment is lowered into the well – can now be avoided. The Variable Valve in either Baker DIFFERENTIAL or Baker FLEXI-FLOW "Fill-up" Shoes and Collars, permits casing to fill from the bottom up; eliminates expensive, time-consuming surface filling; and automatically coordinates the *rate of fill* with the *rate of lowering* to AVOID high pressure surges. Baker FILL-UP Equipment permits the casing to be lowered at normal rates, saving rig time and reducing danger of sticking the pipe; chances for successful primary cementing are increased; formations are protected from high pressure surges which can impair their productivity.

neer to determine if additional data not usually available to field personnel should be considered. The various other departments affected then review the proposed recommendation.

Coordination with Other Departments or Specialized Personnel Important

Land. This department is concerned because the work could result in loss of the property if it is the last well on the lease. There may also be other requirements concerning development of new producing zones. They also may know of management plans of other operators, pipelines or gas plants that could have an effect on the timing of the work being recommended.

Title record. This department is concerned with lease status, special terms, and expiration dates. Many lease forms have special clauses and other agreements. It requires a person with special training and experience to understand and interpret these special conditions.

Legal. This department works very closely with the land and title record departments. They determine if past production or payments have kept the lease in force. They also determine if leases may be combined or unitized. Irregular contracts can cause considerable trouble; this is further complicated because each state has different laws and interpretation of contracts even for standard forms.

Accounting. This department will provide actual detailed costs of previously completed well work for analysis and as a check on estimated costs for well work. The statistics and lifting cost section of the accounting department will furnish lease operating cost figures. The lifting cost of a lease is expressed in cost per dollar of revenue. Cost per barrel of oil or per MMcf is not applicable as many operating leases have several different sources of income. Analysis is needed to determine if lifting costs are reasonable and if they can be reduced. This analysis requires expert production experience to determine what costs are fixed, which can be reduced and if a saving can be effected by abandonment of either the well or the lease. A distinction should be made between direct costs, such as pumpers' labor, taxes, fuel, etc. which can be controlled, and indirect costs, such as area and district overhead, over which there is little control.

Part interest. Unitization and part-interest agreements vary considerably regarding the authority of the operator. Therefore, it is necessary to know what the maximum permissible expenditure is under the agreement without authorization. Some authorizations are granted in letter form; others require

Form O-444
Printed in U.S.A.

LEGEND

g = Capacity
* = High GOR
TR = Trace
E = Estimated
T = Curtailed to Schedule Allowable
o/s = Subject to Special Gas Limit
NA = Ratio Not Available or Applicable
W = Allowable Exempt from Shutdown
R = Results
S = Successful
PS = Partially Successful
US = Unsuccessful
AR = Allowable Restricted
OF = Open Flow

LEASE AND WELL		WELL WORK Completion Date	WELL WORK Total Days	FIELD	FORMATION	CLASSIFICATION OF WORK	REASONS FOR WORK
Fred Snuggs	#21	1-6	27	Walnut Bend	2600' Sand	Dual Re-Comp	Improve Prod.
Fred Snuggs	#14	2-7	3	Walnut Bend	Cox Sand	Workover	S.O.W.
Fred Snuggs	#4	2-18	4	Walnut Bend	Walnut Bend	Workover	Improve Prod.
Sun-Tex Gibson	#1	4-17	28	Sivells Bend	Dillard Sand	Workover	Improve Prod.
Lee Hudgins	#2	4-14	5	O'Hagen	Upper Davis	Workover	Improve Prod.
Fred Snuggs	#5	8-10	63	Walnut Bend	2600' Sand	Dual Re-Comp	Improve Prod.
Barret Brown "A"	#1	7-8	6	Big Mineral	"V" Sandstone	Workover	Improve Prod.
Fred Snuggs	#19	8-16	3	Walnut Bend	Bruhlmeyer Sd	Re-Comp.	Improve Prod.

PRODUCTION SUMMARY

		OIL - WITHOUT W/O	AFTER W/O	NET GAIN
Fred Snuggs	#21	0	3,154	3,154
Fred Snuggs	#14	2,750	3,359	609
Fred Snuggs	#4	2,800	6,569	3,769
Sun-Tex Gibson	#1	1,700	5,464	3,764
Lee Hudgins	#2	1,325	3,137	1,812
Fred Snuggs	#5	0	0	0
Barret Brown "A"	#1	655	3,432	2,777
Fred Snuggs	#19	313	3,199	2,886
	TOTALS	9,543	28,314	18,771

(a) If allowable cut is anticipated, use whichever is less. (b) If production is restricted, show top legal production an

an AFE (authorization for expenditure). What special options apply if the partners cannot agree on the proposed work? What is the correct procedure for transferring new or used equipment to or from the lease?

Part-interest and legal departments also have the problem of interpreting unitization, partnership or farm-out agreements to determine which zones can be produced and under what circumstances. What happens if a jointly owned well is recompleted in a zone which is not covered by the operating agreement? How is a zone farmed out or unitized for gas handling if it unexpectedly tests oil, or worse yet, if it first produces gas, then starts producing oil? If unitization is contemplated, should the work be delayed so the unit can share in the cost of the work? Or should the work be done immediately so that the unit participation percentage can be increased?

Geological. This department maintains correlation and structure maps, recommends additional drilling or recompletion attempts. In addition, assistance of a log specialist is very necessary in some areas because of the variables and inconsistencies found in interpretation from field to field. All logs apparently have some fields in which their information appears amazingly consistent and in which a relative novice can make excellent interpretations. Thus, the tendency, unfortunately, is to assume that the logs are easy to read and what applies to one section may be the same for all sections. This is not correct, and the logging specialist should be called upon for his assistance when it is warranted.

Production laboratory. The laboratory will analyze cores and samples of produced water and oil. They will suggest various treating materials and explain the probable effects on well productivity. They will advise or warn of the effects of certain materials normally used in killing a well, and explain their reasons for recommending a particular "friendly fluid."

Gas department. The gas department needs to be consulted to determine if they can utilize the gas now, and if the pipeline and plant facilities will handle the additional load. If gas is needed later, can it be stored or production delayed? What is the expected revenue from gas and associated liquids? Will recompletion result in curtailed production from existing wells?

Purchasing department. This department handles contracts for all service companies, rig or workover rig con-

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SUN OIL COMPANY—WELLWORK SUMMARY—195__

AREA GAINESVILLE

DISTRICT TYLER

PROCEDURE	COST EST.	COST ACTUAL	COST SUM	SCHEDULE ALLOWABLE WELL Max.	SCHEDULE ALLOWABLE WELL Marg.	SCHEDULE ALLOWABLE BEFORE W/W (a)	PROD. BEFORE WELLWORK O-W-GOR (b)	REPRESENTITIVE TEST AFTER W/W O-W-GOR	END OF YEAR PRODUCTION O-W-GOR	A.R.	R.
Set Plug, Perf. 2639-44', Frac., Run Parallel Tbg. strings	3,620	6,391	6,391	45	20	0	0 - 0 - 0	9 - 72 - 250	4 - 55 - 235	P	S.
Sqz. Open Hole 2912-22', Drl. Out To 2913', Perf. 2906-10'	2,481	2,548	2,548	45	20	17M	9-249-NA	14 - 107 - NA	8 - 126 - NA	P	U.S
Frac. O.H. 4921-80' w/15,000 gal. So. Dove Oil/12,000#	3,366	2,464	2,464	43	20	40	8 - 2 - 193	97 - 0 - 278	18 - 4 - 181	F	S.
Frac. O.H. 7368-78' w/20,000 gal. So. Dove Oil/16,000#	3,435	4,164	3,331	121	30	101	13-Tr.-2400	35 - 10 - 2400	1 - 6 - NA	P	S.
Frac. Perfs. 8646-93' w/30,000 gal./24,000# Sd., 150 Balls	4,880	2,656	2,656	122	35	14	9-0-17,493	47 - 0 - 6541	20 - 0 - 4980	*	S.
Perf. Hudspeth Zone, RE-Comp. as Dual w/Walnut Bd Sand	7,346	20,496	20,496	65	20	0	0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	P&A	US
Set B.P. 7620', Perf. 7460-72', Frac. w/10,000gal/8000# Sd	3,554	3,407	3,407	121	30	29M	10-0-750	106 - 0 - 649	18 - 0 - 750	P	S.
Set B.P. 3800', Perf. 3468-76', Frac. w/8,000gal/6000# Sd	3,045	2,553	2,553	65	20	3M	3-28-711	64 - 0 - 300	19 - 2 - 300	F	S.
TOTALS:	31,727	44,679	43,846				52 BOPD	372	88 BOPD Calendar Day		
Eight Well Estimating Factor = ~~44,679~~ / ~~31,727~~	=	1.41									
Additional Oil Resulting From W/O	=	36 bbl/day									
Cost Analysis - At End of Year (36 BOPD)	=	$1.241 per bbl									
Payout = ~~$44,679~~ / ~~$72. per day~~ = 621 Days (Calc. on Basis of $2. per bbl.)											
Additional Oil Produced to 1-1-58	=	18,771 bbl									

d reasons for restriction, if other than top well allowable.

FIG. 2. **Form O-444, Wellwork Summary,** presents a summary of previous workovers performed in the various areas. This report is the basis of wellwork summaries prepared annually in all areas, districts and the Dallas division.

tractors, trucks, etc. and verifies their insured status with the insurance department. In conjunction with the material expeditor, they see that unused equipment such as odd size, and/or plastic lined tubing, multiple string packers and Christmas trees are available at the proper time. Failure to coordinate material requirements costs money in rig and employee time; emergency substitutes can be dangerous and are usually less efficient.

Tax department. Will the proposed work have a bearing on local, state, or other taxes?

Civil engineering and right-of-way. Repairs to bridges, docks, platforms or roads are expensive and should be taken into account. If they require rebuilding or new construction, they can be very costly and seriously affect economics of the proposed work. Right-of-way or damage claims must be considered. Crop damage can sometimes be avoided with slight delay until the crop can be harvested. In some instances, this also applies to roads and other considerations where weather can be a factor.

Proration and state rules. The rules of the various state regulatory bodies are very complex with many special provisions and are not very uniform between states. Continuous checking is required to prevent violation. This department is very alert and constantly studying to determine if the proposed work is necessary or if field rules may be changed to prevent economic waste or expenditure for the work. They also request change in rules to insure equitable production between leases and fields.

Field engineers. These engineers, in addition to preparing well work Form 0-341, are also responsible for well tests, bottom-hole pressure tests, pressure buildup tests and cumulative production records. They are also responsible for reporting outside operations of unusual interest in the area.

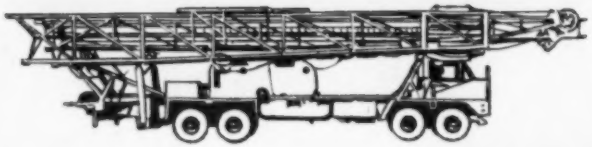
Reservoir engineers. Reservoir specialists will predict reservoir performance and recommend the best method of producing the reservoir. They will estimate reserves and present worth of reserves. They have the responsibility of timing the work. If work on the well or project is completed too far in advance and cannot be produced or used for some time, the investment will be idle and payout delayed.

Corrosion engineers. These people are continuously studying all operations in order to reduce expenses and prevent dangerous situations from arising. Their recommendations for selection and protection of equipment is of constantly increasing importance as material and labor costs for replacement rise.

Production engineers. Production engineers are faced with a constantly changing situation with new developments. They must keep themselves informed as to the newest and best services, newest, safest and most economical techniques, and the best equipment.

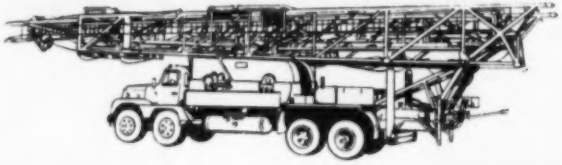
Regional superintendents. Superintendents have many operating conditions that must be considered. Will the work increase or decrease labor requirements, mileage charges for supervisors' time? Is the lease isolated where production or supervision is a problem? What effect will the work have on other lease equipment such as salt water pits, salt water disposal systems, new tanks, treaters, separators, etc.? Will the proposed work result in making some of the equipment surplus for use elsewhere? There are a large number of expenses indirectly connected with well work that can make the difference between a profitable or a non-profitable operation. Should the lease be farmed out, or the lease operation contracted if company labor is

FASTER PULLING
FASTER MOVING
FASTER SERVICE
LONGER LIFE



Explorer

New from wheels to crown. Power up to 400 HP. New main drum design for fast, safe pulling. New water and air cooling brake system. Models to 12,000 feet.

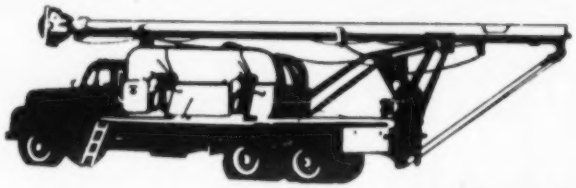


Rocket

A singularly efficient and economical line with single or tandem front end. Three models with capacities ranging to 12,000 feet.

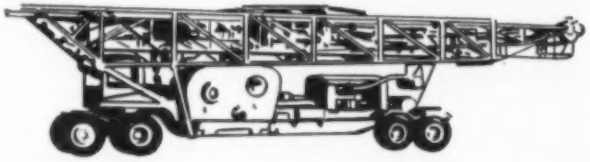
A FRANKS MODEL FOR EVERY WEL

L SERVICING AND WORKOVER NEED



Cruiser

The most widely accepted servicing unit in the field. Eight models, single or double pole masts. All balanced capacities to 12,000 feet.



Clipper

Self-propelled integrated units that head into location instead of backing in. Three models with servicing and workover capacities to 14,000 feet.

Franks gives you a unit to match every job in the field and then backs it up with 24-hour parts and field service.
You can depend on FRANKS.

WELL SERVICING AND DRILLING UNITS
FRANKS
DIVISION OF
PAMPA, TEXAS
CABOT SHOPS INC.

inadequately utilized?

Management. They also have many special problems. Does this work, by its nature, tend to set up a precedent in an area that would increase the operating difficulties or expense in an area? Management may sometimes be faced with the decision to authorize work contrary to the recommendation of one department, but, beneficial for the company as a whole.

Number of Wells Affected Important

The potential reserves of the area should be borne in mind when all of the information available from the various sources has been considered. If the results of the work can only affect one or possibly two wells with a small acreage, it would be a poor risk to consider the work with a 50 percent chance of success. However, the same work with even a 25 percent chance of success would be favorably considered if it could affect as many as eight wells on a large block of acreage.

Watch for Change in Producing Days

The number of producing days is of great importance on the proper timing for well work in Texas. This is especially true if the marginal allowable is high and approaches, or is equal to, the top field allowable. In the East Texas field, with marginal and top allowable of 20 bbl of oil per day, a marginal well on the east side that can only pump 7 bbl of oil per day is equivalent to a well that can flow a month's production in a day, but is restricted to 7 bbl of oil per calendar day with only 11 producing days for the month. Admittedly, there is a difference in operating costs because of the pumping unit. However, economics would prevent work to fracture with a high volume, high rate treatment because past experience has shown that this type treatment probably will result in sufficient increased production for the well to be subject to shutdown days. This is a hard decision to make as such benefits from the treatment could last for many years in this particular area. Experience is a very large consideration in any type work such as plug back or squeezing in the same zone to shut off water in a gas well.

Value of Records

Well work records in our division have been filed separately by leases and fields since 1951. This permits rapid searching for results of work peculiar to an area or for results of a single type operation or in this particular problem. In the specific case of attempting to shut off water in the same zone of a gas well, it was found recently that there had been a large number of these jobs performed since 1951. The number was sufficient to warrant statistical analysis. It was found that only 20 percent of the jobs were successful. This finding was significant in bringing to light the difficulty of effectively shutting off normal water encroachment in a gas sand.

This is an example of how the study of workovers on a divisional level can be used to prevent expenditures that have very little chance of success.

When Should Workover Be Performed?

The consideration of when to do work should be governed almost exclusively by the answer to the question, "When will the cost of the work be returned?" From time to time, a proposal will be made to do the work while the well is capable of making top field allowable or so close to the top field allowable that the work cannot show a reasonable payout. Many theories will be advanced to support the contention that the work should be performed immediately. In very special cases, a point can be proved that a better treatment can be performed while the bottom-hole pressure is high or before the well commences to make water. In other cases, need for immediate information has been cited. Experience has shown that a large percentage of the rush jobs did not pay out in either the short or the long-term haul. Some other factor, not considered at the moment, always seems

A Typical Annual Division Summary of Wellwork(1)

CLASSIFICATION	No. Jobs	Results S	Results PS	Results US	COST Total	COST Average	OIL PRODUCTION Barrels of Oil per day Before	Barrels of Oil per day Immed. After	Barrels of Oil per day Year's End	Barrels of Oil per day Net Gain Yr's End	Barrels Since W/O	Barrels Net Gain Yr's End	Wells Restricted By Allow.[2]
OIL WELLS													
Deepening	5	1	2	2	$ 57,000	$11,400	14	175	44	30	10,732	7,739	—
Recompletions	31	22	1	8	182,000	5,871	80	1,574	424	344	89,176	73,882	9
Workovers:													
Shut Off Gas	3	3	—	—	19,000	6,333	14	87	83	69	8,783	7,902	—
Shut Off Water	29(5)	21	2	6	102,000	3,517	546	985	643	97	109,450	38,599	20
Improve Production	103	75	3	25	340,000	3,300	1228	6,927	2746	1518	538,986	304,162	44
Repairs	20(4)	18	1	1	41,000	2,050	691	835	713	22	93,886	25,580	17
Sub-Total	191	140	9	42	$741,000	$3,880	2,573	10,583	4,653	2,080	851,013	457,864	90
GAS WELLS													
Deepening	—	—	—	—	—	—							
Recompletions	4	3	1	—	$ 31,000	$7,750							
Workovers:													
Shut Off Water	3	2	—	1	29,000	9,666							
Improve Production	3	2	—	1	2,100	700							
Repairs	10	10	—	—	63,000	6,300							
Sub-Total	20	17	1	2	$125,100	$6,255							
PROJECT WELLS													
Conversion	14	14	—	—	$ 61,000	$4,357							
Improve Injection	10	7	1	2	28,000	2,800							
Repair Injection Wells	4	4	—	—	17,000	4,250							
Recompletion	—	—	—	—	—	—							
Improve Water Supply	—	—	—	—	—	—							
Repair Water Supply Wells	—	—	—	—	—	—							
Sub-Total	28	25	1	2	$106,000	$3,786							
GRAND TOTAL	239	182	11	46	$972,100(3)	$4,067							

LEGEND

S . . . Successful (Recovered more than 150% of cost)

PS . . . Partially Successful (Recovered from 100 to 150% of cost)

US . . . Unsuccessful (Recovered less than 100% of cost)

(1) All figures shown are for illustration purposes only and are not actual figures.

(2) Indicates wells at year's end with production restricted by allowables.

(3) This represents total cost of performing the work. The net expense to Sun totals $775,000. The remainder is charged to working interest partners.

(4) Fourteen oil wells with more than 1200 psi on casing were worked on at a cost of $11,116 to run packers to protect casing but did not increase production.

(5) Sixteen top allowable wells in the East Texas field successfully shut off a trace of water to keep the wells flowing. Did not increase production but eliminated pumping unit installation.

FIG. 3. Division Wellwork Summary is prepared each year from area and district summaries (Form O-444). The most important figure in the report is the net gain in calendar-day production at the end of the year. It should be noted that net gain realized at yearend should be considered as an average producing rate for all wells six months after the work. This is also true for net gain in cumulative production.

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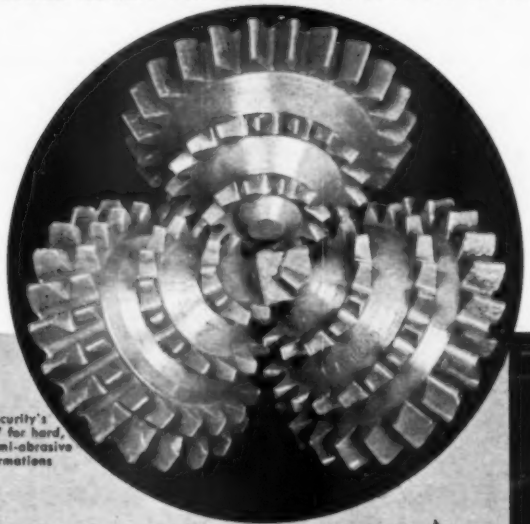

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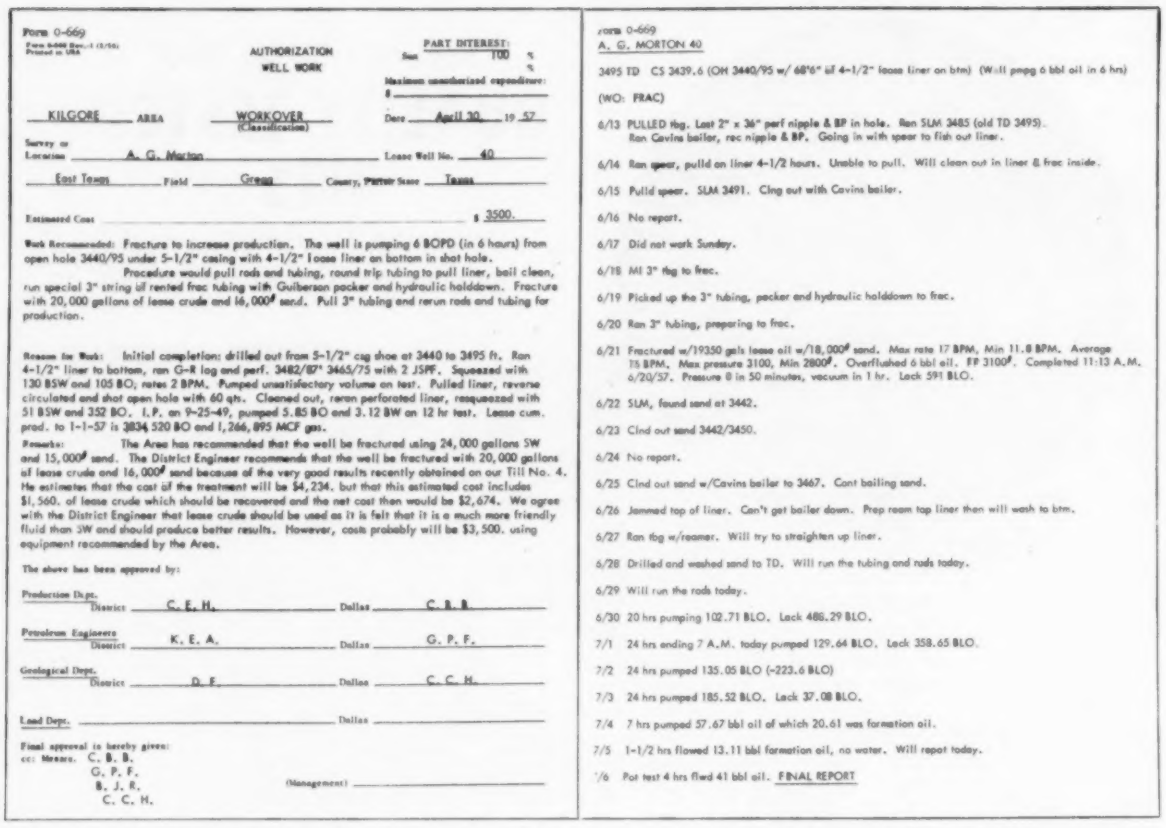
W. HEMISPHERE: Security International C.A., Caracas, Venezuela

E. HEMISPHERE: Security International C.A., London, England



Form O-669

AUTHORIZATION
WELL WORK

PART INTEREST:
Gas 100 %
%

Maximum unauthorized expenditure:
$

KILGORE AREA | WORKOVER (Classification) | Date April 30, 19 57

Survey or Location A. G. Morton | Lease Well No. 40

East Town Field | Gregg County, Porter State Texas

Estimated Cost $ 3500.

Work Recommended: Fracture to increase production. The well is pumping 6 BOPD (in 6 hours) from open hole 3440/95 under 5-1/2" casing with 4-1/2" loose liner on bottom in shot hole.

Procedure would pull rods and tubing, round trip tubing to pull liner, bail clean, run special 3" string if rented frac tubing with Guiberson packer and hydraulic halddown. Fracture with 20,000 gallons of lease crude and 16,000# sand. Pull 3" tubing and rerun rods and tubing for production.

Reason for Work: Initial completion: drilled out from 5-1/2" csg shoe at 3440 to 3495 ft. Ran 4-1/2" liner to bottom, ran G-R log and perf. 3482/87' 3465/75 with 2 JSPF. Squeezed with 130 BSW and 105 BO; rates 2 BPM. Pumped unsatisfactory volume on test. Pulled liner, reverse circulated and shot open hole with 60 qts. Cleaned out, reran perforated liner, resqueezed with 51 BSW and 352 BO. I.P. on 9-25-49, pumped 5.85 BO and 3.12 BW on 12 hr test. Lease cum. prod. to 1-1-57 is 3834 520 BO and 1,266,895 MCF gas.

Remarks: The Area has recommended that the well be fractured using 24,000 gallons SW and 15,000# sand. The District Engineer recommends that the well be fractured with 20,000 gallons of lease crude and 16,000# sand because of the very good results recently obtained on our Till No. 4. He estimates that the cost of the treatment will be $4,234. but that this estimated cost includes $1,560. of lease crude which should be recovered and the net cost than would be $2,674. We agree with the District Engineer that lease crude should be used as it is felt that it is a much more friendly fluid than SW and should produce better results. However, costs probably will be $3,500. using equipment recommended by the Area.

The above has been approved by:

Production Dept. District C. E. H. Dallas C. B. B.

Petroleum Engineers District K. E. A. Dallas G. P. F.

Geological Dept. District D. F. Dallas C. C. H.

Land Dept. Dallas

Final approval is hereby given:
cc: Messrs. C. B. B.
G. P. F.
B. J. R.
C. C. H.
(Management)

Form O-669
A. G. MORTON 40

3495 TD C5 3439.6 (OH 3440/95 w/ 68'6" of 4-1/2" loose liner on btm) (Well pmpg 6 bbl oil in 6 hrs)

(WO: FRAC)

6/13 PULLED tbg. Lost 2" x 36" perf nipple & BP in hole. Ran SLM 3485 (old TD 3495). Ran Cavins bailer, rec nipple & BP. Going in with spear to fish out liner.

6/14 Ran spear, pulld on liner 4-1/2 hours. Unable to pull. Will clean out in liner & frac inside.

6/15 Pulld spear. SLM 3491. Clng out with Cavins bailer.

6/16 No report.

6/17 Did not work Sunday.

6/18 MI 3" tbg to frac.

6/19 Picked up the 3" tubing, packer and hydraulic halddown to frac.

6/20 Ran 3" tubing, preparing to frac.

6/21 Fractured w/19350 gals lease oil w/18,000# sand. Max rate 17 BPM, Min 11.8 BPM. Average 15 BPM. Max pressure 3100, Min 2800#. Overflushed 6 bbl oil. FP 3100#. Completed 11:13 A.M. 6/20/57. Pressure 0 in 50 minutes, vacuum in 1 hr. Lack 591 BLO.

6/22 SLM, found sand at 3442.

6/23 Clnd out sand 3442/3450.

6/24 No report.

6/25 Clnd out sand w/Cavins bailer to 3467. Cont bailing sand.

6/26 Jammed top of liner. Can't get bailer down. Prep ream top liner then will wash to btm.

6/27 Ran tbg w/reamer. Will try to straighten up liner.

6/28 Drilled and washed sand to TD. Will run the tubing and rods today.

6/29 Will run the rods today.

6/30 20 hrs pumping 102.71 BLO. Lack 486.29 BLO.

7/1 24 hrs ending 7 A.M. today pumped 129.64 BLO. Lack 358.65 BLO.

7/2 24 hrs pumped 135.05 BLO (-223.6 BLO)

7/3 24 hrs pumped 185.52 BLO. Lack 37.08 BLO.

7/4 7 hrs pumped 57.67 bbl oil of which 20.61 was formation oil.

7/5 1-1/2 hrs flowed 13.11 bbl formation oil, no water. Will repot today.

7/6 Pot test 4 hrs flwd 41 bbl oil. FINAL REPORT

FIG. 4. Form O-669, Authorization Well Work, is prepared by the petroleum production engineer and submitted to management for approval or disapproval. The form outlines the work recommended and presents the reasons for the requested work, as well as giving a reasonable estimate of the cost of the project. Upon approval and subsequent completion of the work, the procedure and results are shown chronologically on the back of the form.

to intervene to change the values unfavorably.

Intangible Benefits of Workover

It must also be realized that there are many intangible benefits from well work that are difficult to evaluate. Management may consider such benefits as eliminating or deferring the investment in artificial lift equipment and the higher attendant operating costs in materials and manpower. In other instances, it has delayed or eliminated the cost of emulsion treating systems and salt water disposal systems. Remedial work can also forestall the loss or deferment of production from dead wells and the cost of well stimulation by swabbing. The work can also be performed solely for the conservation of reservoir energy. Results of work on gas wells are usually more difficult to evaluate, but remedial work can sometimes delay expensive compressor stations as well as increase production rates. Project wells fall in another category in that the result of work on these wells is evaluated by the overall success of the project. They may also be tied into the operation of water floods, pressure maintenance projects or unit operations that could materially increase the ultimate recoverable reserves.

Summary of Workovers

Well work summary, Form 0-444, is shown in Fig. 2. This form is used by each area to summarize its previous workovers. Each area, district and the Dallas division then compiles its annual statistical summary from the data submitted on the various area summaries, Forms 0-444. A recent division summary is shown in Fig. 3. This form has no company-designated number.

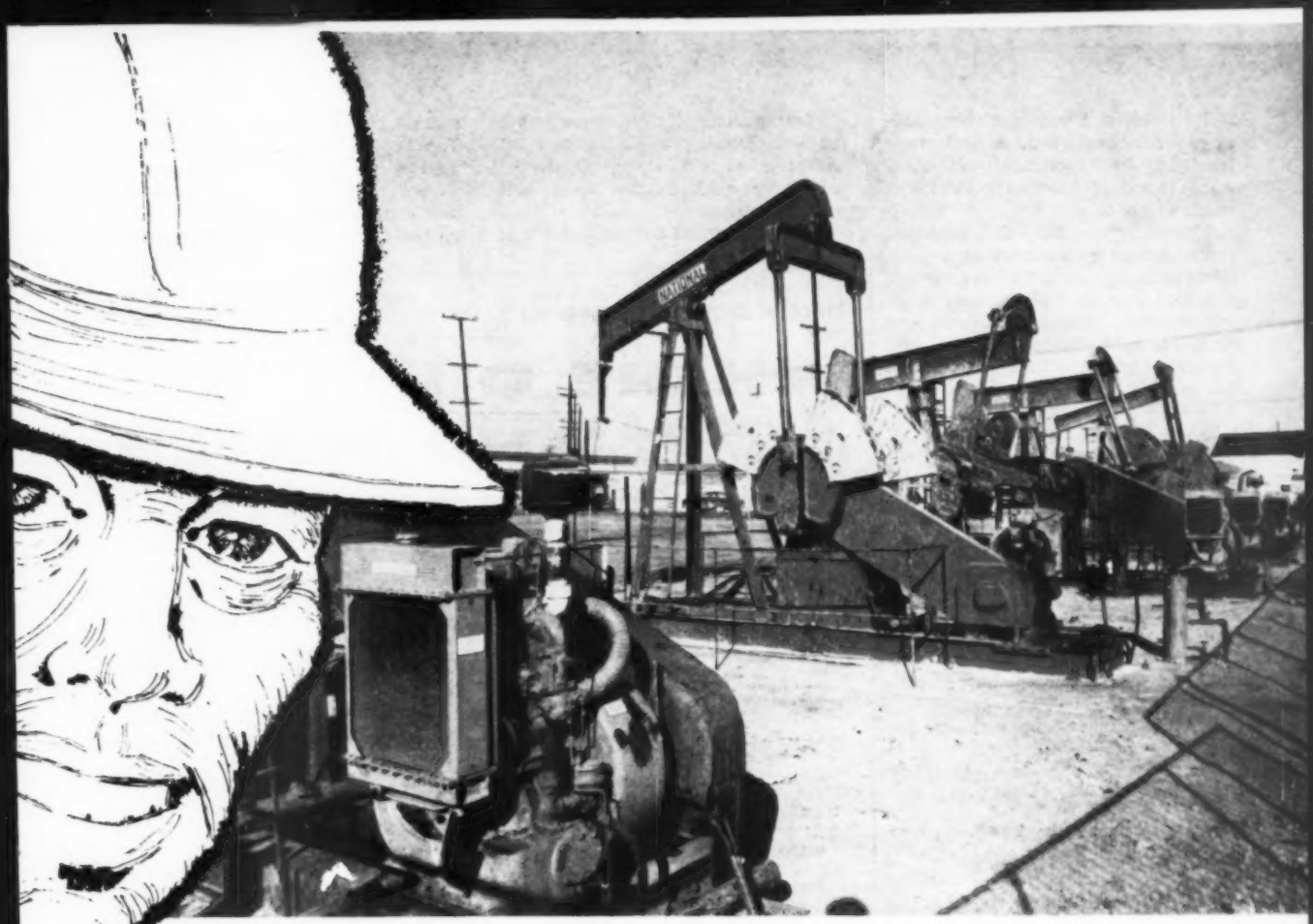
The most important figure in the division summary is the net gain in calendar-day production at the end of the year. It should be noted that the net gain per day realized at the end of the year should be considered as an average production rate for all of the wells six months after the work. This is also true for the net gain in cumulative production. In both cases, our experience shows that the work done in January will average out with the work done in December. This net gain in cumulative for the year is obtained by estimating the production as if no work had been performed, and subtracting it from the actual production.

The division in order to simplify analysis of the work uses an arbitrary net gain of $2 per bbl for the extra oil. The average payout in recent years has slightly exceeded one-half year. More recently this payout period has been reduced to substantially less than one-half year. *This improvement is a direct result of additional experience with this system of analyzing well work.* The year 1958, however, will result in a substantially longer payout because of the reduction of allowables in other states and the drastic reduction in producing days in Texas.

It should also be pointed out that the summary is not carried beyond the end of the calendar year in which the work was done. However, because of the 90 wells at the end of the year whose capacity was in excess of the current allowable and whose production was being restricted by allowables, each succeeding six months' extra production should decrease only by possibly 10 to 15 percent.

Other Sources of Information

It would be difficult to compile a complete check list of all of the sources of information and what benefit can be obtained from each source. Misleading information, in some instances,



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will be obtained and must be recognized and disregarded. A well work specialist, by experience, will know where to seek his information and how much weight to give it.

He will review the well completion record, giving special attention to such items as casing size and weight, cement top, core analysis, drillstem tests, treating volumes, treating pressures and rates. He must absorb a mass of data that could have a bearing on the work. He must be alert to check errors that may have crept into the recommendation. He must be acquainted with engineers in other companies in order to obtain reliable information of area and offset operations.

Another source of information is the service company personnel. Our experience has been that service companies have qualified representatives who are pleased to help with any unusual problem. They appreciate your request and are willing to go to considerable trouble and research to provide the correct answer.

Unfailing sources of information are papers in publications of the various technical organizations and trade magazines.

Final Processing by the Management Team

Before any major change is made by the district or division personnel in the techniques, materials and tools to be used, the district is requested to review these changes. And if necessary, the area will present a new estimate for the revised program; this procedure takes advantage of the best in everyone's recommendations for each well workover. Well workover requests are stimulated because all personnel can thoroughly understand why each request is approved or disapproved.

When all of this information has been considered, the Authorization Well Work Form 0-669, commonly referred to as a green sheet, is prepared. Fig. 4 shows a sample of Form 0-669. This form is prepared by the petroleum production engineer and submitted to management for approval or disapproval of the proposed project. Copies are provided for all interested company personnel or departments contributing to the recommendation. When management authority returns the green sheet, approved or disapproved, the Well Work Recommendation Form 0-341 is revised to show any changes made.

Conclusions

The need for records varies with every company, depending on its size and scope of operation. However, the author believes every company can benefit by carefully analyzing its entire well work program. To do this in an efficient manner, it is necessary that the best records possible be compiled and reviewed regularly by all personnel whose work touches upon well work operations.

Even in a small company this can mean a considerable organizing effort. The author hopes the successful results enjoyed by Sun Oil Company in its well work program will indicate how rewarding this effort can be when properly organized and administered.

* * *

Here's a producing area . . . P 532.

WHERE OIL AND WATER MUST NOT MIX

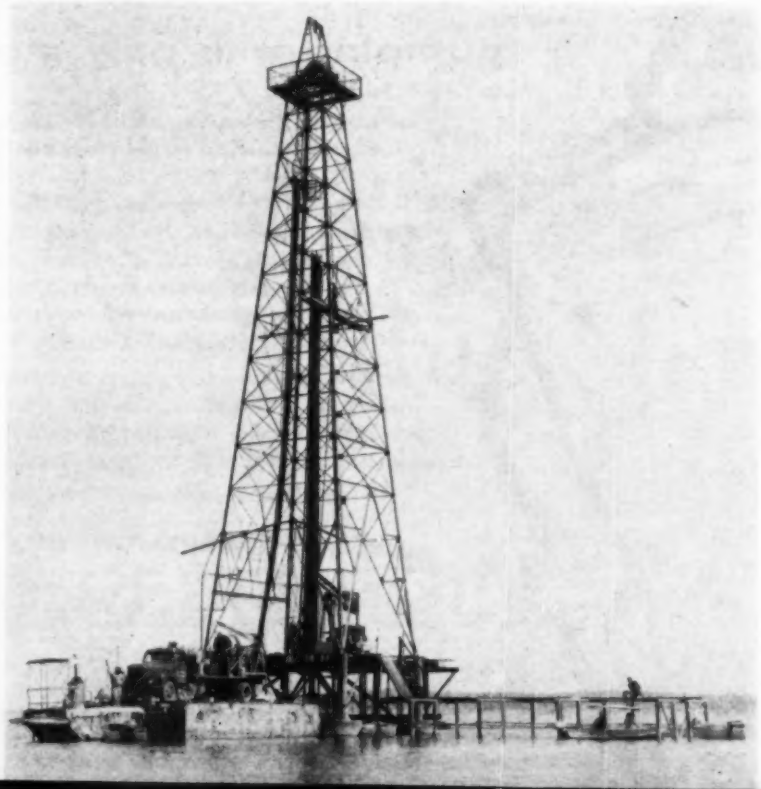
Leonard A. Price,
Price-Caudle Well Service, Inc., Seminole, Oklahoma

Well servicing crews operating in Lake Texoma must work with great care to avoid contaminating the fresh-water lake with oil

AMONG THE MANY thousands of uses for oil, one of the best known is its ability to "smooth troubled waters." But here is one case where a single drop of oil on water can be the cause of trouble. The water in question is that contained in Lake Texoma, the well-known fisherman's paradise formed by Denison Dam on Red River between Oklahoma and Texas. The potentially-troublesome oil is that produced from several wells completed in the lake.

Ashland Oil and Refining Company owns several of the wells completed off-

When tubing is pulled from the hole, it is stripped clean of clinging oil and is stacked in a special vat which catches all oil draining from inside the tubing. Rods are cleaned with a rubber stripper and rags and then stacked in the derrick.



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The accuracy of McCullough Well Logging Services assured the successful reduction of gas/oil ratio in this Canadian oil well.

Depth of operation was approximately 3200'. Seven inch OD 20 lb. casing had been set on top of the pay. Production was from 6⅛" open hole with a gas/oil ratio of 1800 cubic feet per barrel.

McCullough's Radiation Well Logger with Scintillation Detector was run to determine the depth and detail of the oil sand. Simultaneous Gamma Ray and Neutron Curves were recorded. Gas/oil contact was established from the Neutron Curve. Following this a McCullough Caliper Log obtained excellent detail of the open hole.

From this information a production packer was set and the well was put back on production. Gas/oil ratio decreased from 1800 to 200 cubic feet per barrel.

Accuracy plus reliability of down-hole information are prime requisites to the successful completion of jobs like this. And you can be sure of these qualities when you call for McCullough Well Logging Services.

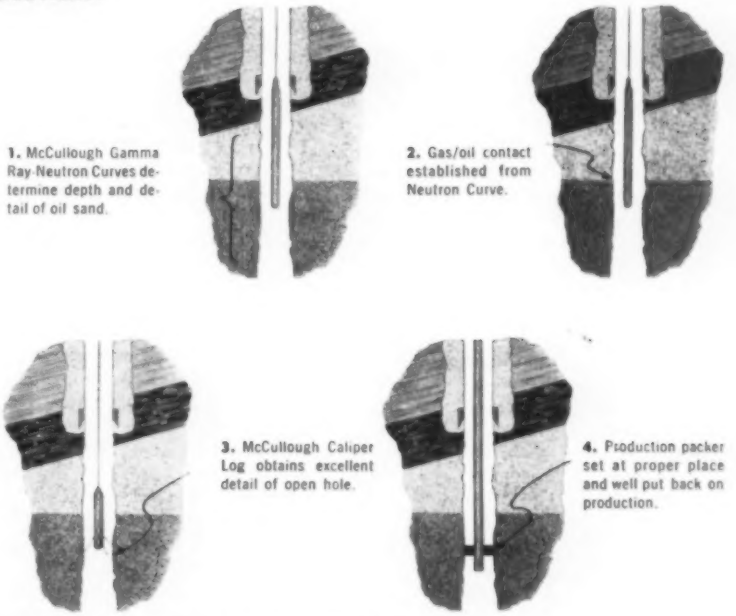
The job described above is certified to be a true field report of service rendered.

WANT MORE INFORMATION?

If you have not received our 12-page bulletin on McCullough Radiation Well Logger, just write McCullough Tool Company, 5820 South Alameda St., Los Angeles 58, Calif. We'll send your copy by return mail.

PROBLEM: Gas/oil ratio too high—1800 cubic feet of gas per barrel of oil.

SOLUTION:



1. McCullough Gamma Ray-Neutron Curves determine depth and detail of oil sand.
2. Gas/oil contact established from Neutron Curve.
3. McCullough Caliper Log obtains excellent detail of open hole.
4. Production packer set at proper place and well put back on production.

RESULT: Gas/oil ratio reduced from 1800 to 200 cubic feet of gas per barrel of oil.

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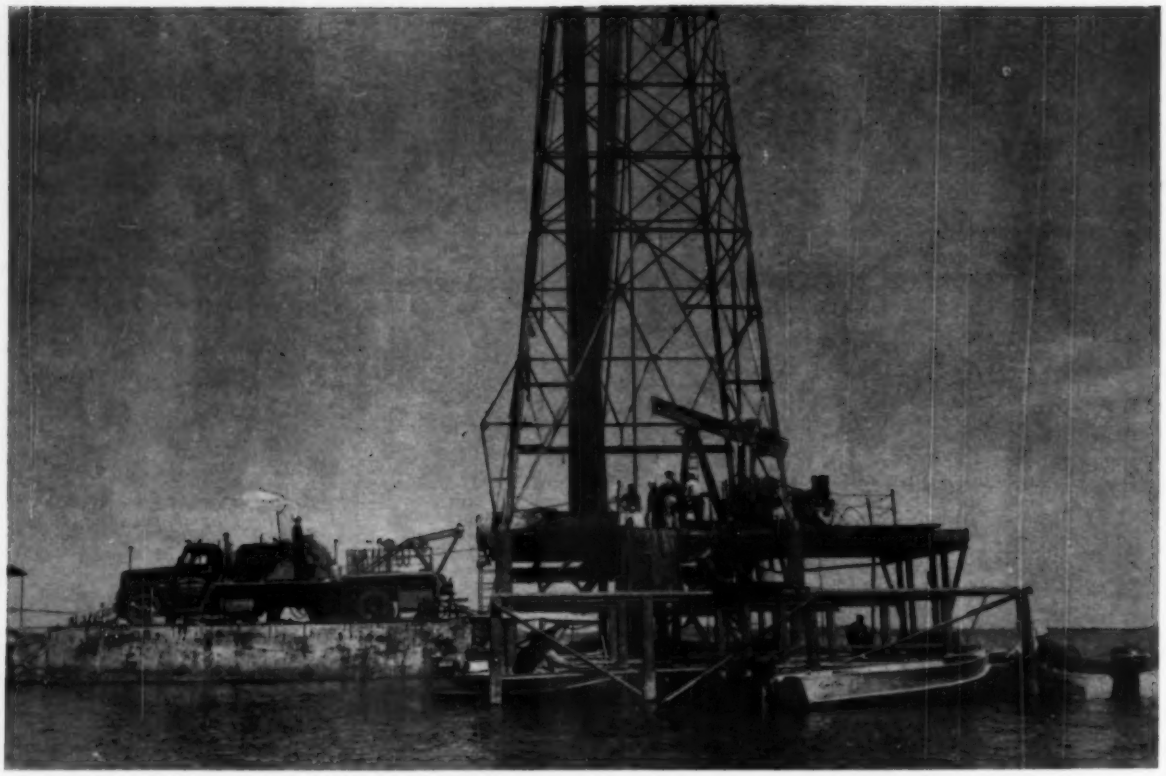

Well servicing unit loaded on barge and anchored at well site. Servicing operations are complicated by necessity of avoiding contamination of the lake with oil.

shore in the lake. Like all oil wells, there comes a time when they, too, must be serviced. There are, of course, many special problems which arise in servicing an oil well completed over water. But, Lake Texoma is a fresh-water lake and that fact alone means problems for both the operator and the servicing contractor. The problem which creates most of the others is how to keep oil from the lake. Not one drop of oil must be allowed to fall onto the water.

When work is planned on one of the wells, one of the first steps to achieve a clean operation is to assure that all of the equipment to be used in the operation is as clean as possible when it leaves the yard of the contractor for the job. For a normal rod and tubing pulling job, a truck-mounted pulling unit and all other necessary equipment are loaded on a barge. The special loading ramp is constructed to permit adjustment for the sometimes rapidly varying lake levels caused by the taking of water or closing of the locks at the dam and heavy rains above the lake. This, of course, changes the loading ramps.

After the barge is loaded, it is powered by a marine motor to the location and anchored at the well. With an average load, the deck of the barge usually rides approximately 5 ft above the water level. At normal lake level, the well floor is approximately 12 ft above the surface of the water. The pulling unit remains on the barge which is securely tied to the platform. Lines are then rigged over the permanently installed standard derrick on the platform.

Before rods are pulled, four or five barrels of fresh water from the lake are pumped down the string of tubing to wash as much oil as possible from the rods. This water is chemically treated to prevent any possible emulsion problem in the well or on the face of the producing formation. The rods are then pulled from the hole through a rubber stripper which removes most of the oil and water from the rods. As a further safeguard against oil clinging to the rods and dripping into the lake, the rods are stripped with rags before being hung in the derrick.

After the rods are pulled, the tubing is again washed down on the inside and outside with water. The tubing is also pulled out of the hole through a rubber stripper and further stripped with dry rags to remove all of the oil and water on the outside of the tubing. The string is then stacked in the derrick, standing in a special water-tight vat which catches all oil and water draining from the inside of the tubing.

Work then proceeds cautiously. When the well is sandpumped, the line must be kept dry in order that no oil can whip from the line into the lake. A tank is provided on the well floor into which the sandpump is carefully dumped. As a final precaution against contamination of the lake with oil, the rig floor must be continuously wiped dry of all spilled oil.

Most of Ashland's wells drilled in the lake were completed in 1950. Average depth of the wells is from 3800 ft to 4200 ft and all of the wells are now produced by pumping.

Well treatment operations performed on the wells must also follow the same rules of caution imposed in well servicing jobs. Trucks and other equipment are loaded on barges which are grouped around the well being treated. In a recent job, a well was fractured with a sand-water mixture, using water pumped directly from the lake. The treatment resulted in an increase in production from the well from 7 to 17 bbl per day.

As a result of the extreme caution with which the jobs are performed, the average working time usually runs from two to three days. But, the jobs can definitely be interesting, especially if the fish hooks are kept well-baited!

* * *

P 974.4

THE ATLANTIC LECTURES OF THE UNIVERSITY OF TEXAS

PART 2

Proration and the Petroleum Engineer

The engineer has emerged as an authority in deciding prudent proration practices. Future of oil conservation is in his hands. Here are a few rules for the engineer at proration hearings

John E. Garrett, *Senior Reservoir Engineer, Atlantic Refining Company, Dallas, Texas*

ONCE UPON A TIME there was a land inhabited by people who were well and prosperous because this land was rich and wild game was abundant. But while these people prospered, they were nevertheless unhappy because there were so many things to do and so many sights to see in this great land that they did not have the strength to do them all. Then one day a great discovery was made. There was in this land a strange bird never before thought of. This bird was not nearly as delicious as pheasant nor did its feathers make pillows as soft as down—but instead this bird possessed a wonderful magic so that whosoever tasted it acquired the strength of many men. So it was that this bird was in much demand.

Now these birds lived together in large coveys but, unlike other game, they could make themselves invisible. However, once any one of them was killed, their power to become invisible was lost, and they would then become easy prey for the hunters.

And so it was that the hunters in this land went about with large guns shooting wildly here and there in an attempt to kill these invisible birds. Upon doing so, the hunters from near and far would come to participate in the shooting—and in each one's effort to bag as many birds as he could, the entire covey would be quickly slaughtered and much waste would occur.

And it came to pass that this bird was named Petroleum.

Now this is a fable but, like all fables, it also tells a true story. This is really the story of our early oil industry—an industry that had its beginning on August 27, 1859, when Colonel Drake discovered oil.

As in the fable, much waste has occurred in our business—a waste that went almost unrestricted until proration came into practice in 1930—just 28 years ago. However, in its relatively short life, proration work has increased until it is now estimated that over *one million engineering man-hours* are spent in this manner yearly. About half of this time is expended on Texas proration, where last year about 2700 public proration hearings were held before the Railroad Commission in Austin.

What Is Proration?

What, then, is the thing called proration that requires so much time? As far as I know, there are no text books on the subject. There are no courses offered on it in college. Many young men when they begin work, know very little about the subject—or, at least, they rarely know that the petroleum engineer is vitally concerned with it.

Proration is the short name given to the conservation practices of proration and regulation.

Regulation is the name applied to the system or collection of state-enforced rules, procedures, and methods that each oil operator must follow. Each oil-producing state has a number of these regulations requiring such things as:

1. Locating of wells a certain distance from lease lines,
2. Proper plugging of wells,
3. Use of blowout preventers while drilling, and
4. Filing of various reports.

Proration is a system or plan that must be inaugurated whenever the producing capacity of our wells exceeds our ability to use the oil or gas. When this happens, our market demand must be prorated out to—or divided among—all of the wells in the state. Market demand is an estimate of the amount of oil that can be used or sold. In other words, if all of our refineries, chemical plants, purchasers, and so on, are able and willing to buy 3,000,000 bbl of oil per day from Texas, we say that the market demand for Texas oil is 3,000,000 bbl per day. It is up to the conservation commission of each state to devise a method or system of apportioning this market demand fairly and

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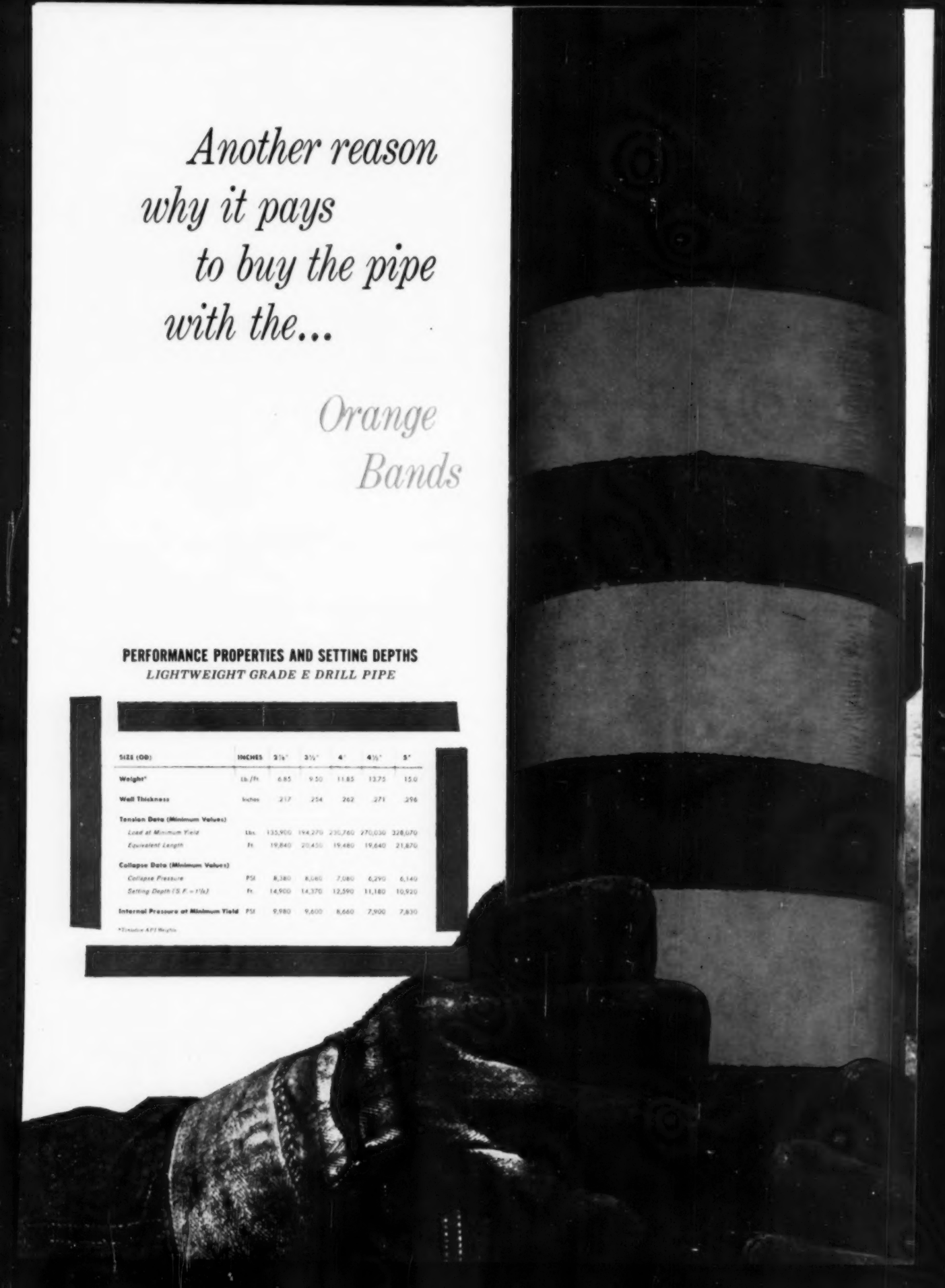

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SIZE (OD)	INCHES	2⅞"	3½"	4"	4½"	5"
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Wall Thickness	Inches	.217	.254	.262	.271	.296
Tension Data (Minimum Values)						
Load at Minimum Yield	Lbs.	135,900	194,270	230,760	270,030	328,070
Equivalent Length	Ft.	19,840	20,430	19,480	19,640	21,870
Collapse Data (Minimum Values)						
Collapse Pressure	PSI	8,380	8,060	7,080	6,290	6,140
Setting Depth (S.F. = 1⅛)	Ft.	14,900	14,370	12,590	11,180	10,920
Internal Pressure at Minimum Yield	PSI	9,980	9,600	8,660	7,900	7,830

*Tentative API Weights

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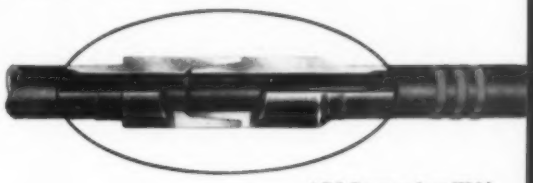

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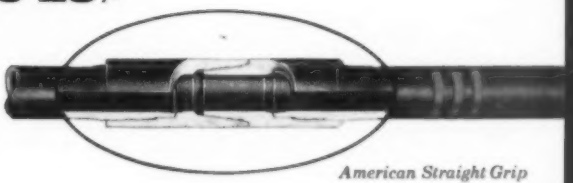

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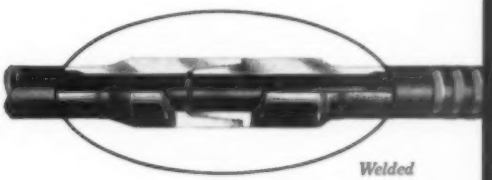

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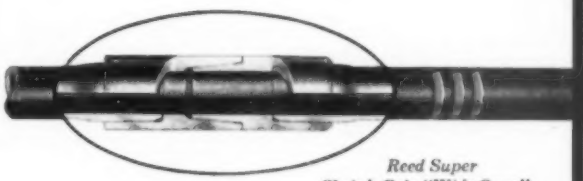
On a 10,000-foot hole, a string of 4½" lightweight drill pipe is 14¼ tons lighter than 4½" regular drill pipe—because it's 2.85 pounds lighter per lineal foot. This means longer drill strings *without increased weight.*



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equitably among all producing oil wells in the state. This system is called proration.

Every oil-producing state has certain laws passed by the legislature, whereby some agency is set up and empowered to do certain things in order to conserve our national resources (oil and gas) and also to protect correlative rights. This agency is usually referred to as the conservation commission. In Texas, it is called the Railroad Commission.

It is this commission that promulgates the rules to prevent waste of our oil and gas and to protect equities. It publishes these rules and from time to time holds hearings to permit exceptions to these rules, or to add to them. For those of you who have not sat in on a hearing, it is somewhat like a trial. The conservation commission is the judge — the various oil companies are the plaintiffs and the defense.

These hearings are usually less formal than a trial; however, the amount of informality varies. The Texas hearings are quite informal while those in Kansas, for instance, approach the formality of a true trial. The witnesses at the hearing are generally engineers or geologists. Lawyers are usually present to direct the examination of witnesses, to cross-examine, and to make statements on behalf of their clients.

Objectives

There are three primary objectives of proration. They are:

1. To prevent waste,
2. To provide equity or to protect correlative rights,
3. To provide incentive for continued exploration and efficiency in the industry.

Waste

One example of waste that can be prevented through effective regulation is oil stored without the aid of tanks. The commission can prevent the use of earthen pits for the storage of oil.

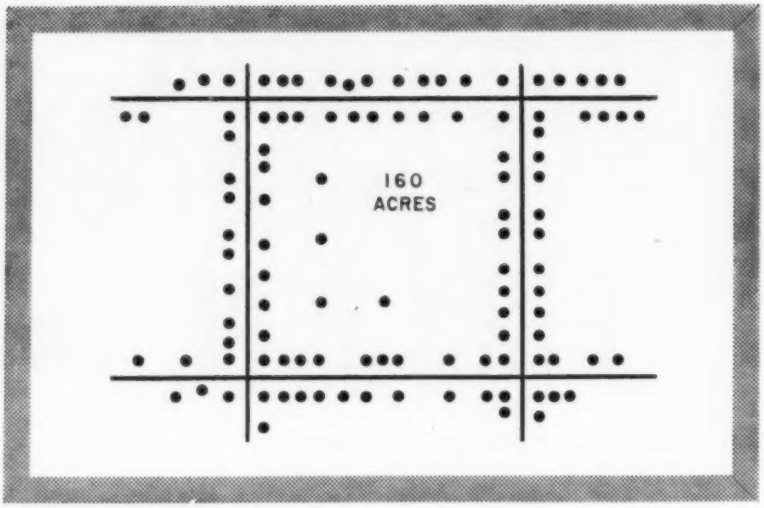
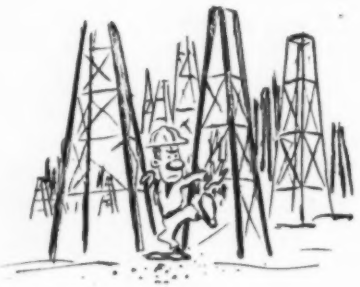


FIG. 1. **Part of the Cushing oil pool** in Oklahoma shows the effect of "line fights" resulting from ineffective well spacing regulations.

This rule prevents waste caused by: (1) Evaporation, (2) fire, (3) seepage into the ground, and (4) pollution of fresh water.

Another example of waste involves proper casing requirements, use of sufficient mud laden fluids, and blowout preventers. Our modern rules and regulations make certain requirements along this line; however, no amount of regulation will prevent the occurrence of the unforeseeable and completely eliminate blowouts.



Well Spacing

Another example of waste can be seen where wells are drilled too closely. This practice can cause underground waste in addition to the tremendous waste of money. Most states now have certain minimum well spacing rules. An example of spacing requirements of various states is seen in Table 1.

In connection with the improper spacing, look at a map of part of the Cushing, Oklahoma, oil pool (Fig. 1). This is a real-life case of well spacing in the absence of effective regulation. Here "line fights" are well illustrated. Wells are drilled very closely along the lease lines while the interior of the leases are undrilled.

For a better feel for proration and regulation, read some of the books written about the early history of our business. One that I would recommend is "United States Oil Policy" by John Ise. After a little reading, you will clearly see that while the birth of the oil industry occurred in 1859, proration or regulation did not begin until some time later.

The biggest reason for the lapse in time before effective proration came about was ignorance. People did not understand the nature of oil and gas. They used to believe that oil was in the earth as a river or lake, extending under and flowing beneath large areas. A tale was told of a driller who lost his watch down a well in Pennsylvania and years later found it in the oil flowing from a well in Texas.

Rule of Capture

It was in this atmosphere that the

TABLE 1. Statewide Well Spacing

	Distance from lease lines (ft)	Distance between wells (ft)	Specified density (acres/well)
Arkansas	330	—	—
Louisiana[1]—oil	330	900	—
—gas	330	2000	—
Mississippi—oil	330	660	40
—gas	990	1980	320
New Mexico—oil	330	660	40
—gas	660	1320	160
Oklahoma[2]	330	600	—
Texas	330	933	20

NOTE [1] Below 3000 ft.
[2] Below 2500 ft.

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Outstanding in performance because it operates perfectly with both zones flowing, high or low differential pressure; with either zone flowing, the other zone pumping; with both zones pumping; with either or both zones on gas lift; or for multi-zone injection — gas or water.

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"rule of capture" was first applied to oil and gas by an 1889 opinion of the Pennsylvania Supreme Court.

This opinion was the first to classify oil and gas, as well as water, with wild animals or birds which belong to and are the property of the hunters who capture them. The court said, "Water and oil, and still more strongly gas, may be classed by themselves, if the analogy not be too fanciful as minerals *ferae naturae*. In common with animals, and unlike other minerals, they have a power and tendency to escape without the volition of the owner. They belong to the owner of the land and are a part of it so long as they are on or in it and are subject to his control; but when they escape and go into other land or come under another's control, the title of the former owner is gone."

If this rule were applied as many people think it was intended, it would mean that as a practical matter the ownership of the oil after it has already been produced must belong to the person who produced it even though *inadvertently* some of it originally was sitting under a neighboring tract of land.

Unfortunately, however, this rule has been applied to permit every land owner or his lessee to drill and produce as he pleases in order to capture for himself all production obtainable from his wells without restriction beyond the requirement that he confine his activities to his own land. In fact, it would seem that many people would prefer to hunt wild game (including oil and gas) without a license.

They don't want a game warden—nor bag limits — nor hunting regulations to forbid poaching.

Under the early atmosphere just described many wasteful practices could occur. Also, it would be difficult to obtain very much unanimity on matters of equity that are inherent in any proration system.

Well Plugging

Of the two conservation practices, regulation initially met with less resistance than did proration. Sometime before 1900, several eastern states passed laws to regulate the plugging and abandonment of dry holes or depleted oil wells. These were probably the first rules of regulations adopted in an attempt to decrease waste. Beginning with these early rules for regulating the plugging and abandonment of oil wells, more and more rules were added, all designed at less wasteful practices.

It may seem odd to people today that it was necessary to pass some of the rules that they did, because a good many of any state's statewide rules and regulations along this vein are only what a prudent operator would do anyway. A person might think, "Why is it necessary for the state to require that I not store my oil in an earthen pit, when everyone knows that it is wasteful?" However, if you will read some of the earlier accounts of the oil and gas industry in the United States and the tremendous waste that was involved, it becomes apparent that the industry was not always as safe and prudent-minded as it is today. There are numerable accounts of rivers and

creeks having been covered with oil which was accidentally ignited, with the result that considerable areas were burned, including bridges and even towns.

The first proration law was enacted by the Oklahoma Legislature of 1915. This law provided that when the full production of a field could be had only under conditions constituting waste (the definition of waste included the production of crude oil in excess of transportation or market facilities or reasonable market demand), the production would be limited to the amount that could be produced without waste. It also provided that each well within a pool, when production was so limited, was to be allowed to produce its pro rata part of the allowed production from that pool. Further, it provided that the market demand for the state was to be equitably divided between pools within the state.

Immediately following the passing of this law, however, World War I caused such a demand for oil that this act was more or less dormant in its application until the late 1920's or early 1930's. However, in 1930, and following the discovery of the great East Texas field, Texas and other states joined Oklahoma in passing a market demand statute which limited production to market demand. Thus, 1930 is actually the beginning of proration.

Much progress has been made in the past 100 years and many concepts have changed. Now we know that oil doesn't run along in caverns—instead it occupies the pore spaces in reservoir rocks. There isn't any appreciable fluid movement within the reservoir until man drills a well into it and starts producing. So as far as our concepts of oil and gas itself are concerned, we currently have no great differences.

Our concept as to who owns this oil and gas, or our concept of rights with respect to this oil and gas, is not so clear. In the beginning the "rule of capture" determined our rights. Petroleum, it was said, was so "flighty" that no one *owned* it but everyone had a *right* to capture as much of it as he could so long as he generally restricted his surface activities to his own leases.

Now, most states have the "in place" theory of ownership, making petroleum ownership similar to coal and other hard minerals. Therefore, the rules regulating the production from each pool are supposed to provide each

TABLE 2. Basis of Proration Decisions

Subject	*Basis of Decision*
Spacing	Reserves, economics, reservoir continuity, economic well producing limit.
Allocation formula	In-place reserves, lease reserves under various allocation formulas.
MER	Realistic rate of production that will not cause a decrease in reserves.
Secondary recovery	Reserves under various methods of operation, economics.
Unitization	Reserves, economics, equities, compliance with state laws.
Cement setting time	Strength versus time for cements, adequate cement strength to prevent breakdown.
Depth of surface casing	Depth of fresh water (electric log interpretation).
Dual or triple completions	Pay quality and quantity at location, reserves, economics. policing.
Spacing exception	Pay quality and quantity at location, reserves, economics.

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owner with the opportunity or right to produce his recoverable oil in place. However, between this theory and the stock tanks, there is considerable confusion and disunity.

For some reservoirs there is no *realistic* allocation rule or allowable formula that will enable each owner to produce the recoverable oil beneath his land. In fact, in some fields there isn't even a conceivable formula that will do this short of field-wide unitization. As yet, we do not have these unitization facilities. As a result, there is a large chasm between what a lot, but not all, of the people in our business feel our rights are and what we actually received. We seem to be in an era of a modified rule of capture. But, if this is so; and, therefore, oil and gas is still like wild game, we can at least say we now have game wardens—the conservation commissions. We have bag limits—that is proration. We have regulations to prevent "poaching." The rule of capture is not extinct, but proration and regulation are not yet perfected either.

What is proration going to be like in the future, and what are engineers going to have to do about it?

Good engineering is the basis of conservation, and the petroleum engineer is therefore the backbone of proration and regulation, both in theory and practice. This can be seen by Table 2, a chart listing some of the principal subjects that must be dealt with in proration. On the right-hand side of the chart is shown the basis of making a decision with respect to each subject shown on the left. You can readily see that these determinations may require the use of every petroleum engineering fundamental you will learn here in school.

At some time in the future, you will probably be asked to make recommendations on or to determine the proper spacing on which a field should be developed. In other words, how far apart should we drill the wells? To determine this you are going to have to determine the amount of reserves that may be recovered by average wells on various spacings; the economics of development on various spacing patterns; the continuity of the producing sand, and on occasions recovery as affected by the economic producing limit of wells.

In the realm of well spacing you may be shocked the first time you have anything to do with it by a misconception still widely indulged in. This concept is that a well in a pool has a specific and finite drainage area. You will be bluntly asked, "How large an area will a well drain in this reservoir or that reservoir?" Your engineering background will make you want to reply that one properly located well will drain, not only the entire oil and gas accumulation but also the entire aquifer if given sufficient time. This answer may rouse skepticism in some people, so as a result we say, "A well will drain in excess of 40 acres," or "in excess of 80 acres," or "in excess of 640 acres," depending on how far we are willing to step out in our development program and how economical or uneconomical the wells are.

Your Recommendations

You will also probably be asked to make a recommendation on, or determination of the proper formula to be used to allocate the total field allowable fairly and properly among all wells drilled within it. To do this you must make determinations as to what producing rates will prevent drainage of your company's or client's property. This requires knowledge of the pool's

producing mechanism and the amount of products in place under each lease.

You will also be expected to make recommendations concerning the MER (or maximum efficient producing rate) for a pool. Here again you will encounter a misconception that may bother some of you. This is so because a majority of the reservoirs discovered have no realistic MER at all. These are the solution gas-drive reservoirs. However, for some pools and especially the water-driven ones this determination can be meaningful. For these a reservoir study will have to be made to predict the reserves of the reservoir as affected by different rates of production. For instance, you may have a field that has a limited water drive such that if the rate of production of the field were limited to 1000 bbl of oil per day, the water influx would essentially keep up with production and would thereby maintain pressure at a level that would not cause a loss of oil recovery.

You will also be expected to make recommendations of or to determine what plan of secondary recovery operations may be feasible for a reservoir. In this connection you will be called upon to demonstrate to the appropriate conservation commission that your secondary recovery plan is necessary and desirable, will increase the recovery of oil and/or gas, will prevent waste, and is economical; and, that they should therefore permit its inauguration.

All these problems require hearings before the various conservation commissions. As stated perviously, a hearing is similar to a trial. The conservation commissioner or one or more of his staff presides at the hearing. There will be a stenographer present who takes down verbatum everything said. When the hearing is over, the stenographer types a transcript of the hearing for use of the commission. Copies of this transcript can also be purchased.

The Hearings

These hearings are open to the public so anyone may attend. Hearing dates and subjects are advertised in newspapers, and in addition those people known to have an interest in the hearing are sometimes mailed a notice of the hearing which sets out the time, place, date, etc.

Anyone who wishes to give testimony at these hearings is sworn in as at a trial. The witnesses are the so-called "experts" and are usually engineers and geologists.

Most companies will have their witnesses presented by an attorney who also may cross-examine other witnesses and make statements.

It is the engineer's job to plan and prepare for these hearings and to be an expert petroleum engineering witness at the hearing.

In preparing for such a hearing, the presentation can be broken down into three phases. During the first phase it is necessary for the engineer to acquaint the commission (or the examiner who represents the commission) with the pool involved and the problems at hand. The engineer must keep in mind that the commission may be quite unfamiliar with the field. I don't mean to imply any laxity by the commission but rather that your field will probably be a newly-discovered one about which the commission has had little opportunity to become acquainted, and secondly, even if it isn't a new discovery, it is rather impossible for a few people to be intimately acquainted with hundreds or thousands of fields.

The second phase of the presentation is to make your request or recommendation as a remedy or as a solution for your problem.

The third phase of the hearing is to prove that your recommendation is sound.

An Example

As an example, if you wish to request that the commission establish an

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order requiring that all wells within field "X" be drilled on an 80-acre pattern, the first part of the hearing is consumed in familiarizing the commission with the field and its reservoir and producing characteristics. In other words, you advise them of the type of structure you have, what the porosity is, what the permeability is, how thick the pay is, where it is located and anything else that is necessary to familiarize the commission with the field.

The second part of the hearing is your recommendation to the commission that to prevent the drilling of unnecessary wells and to enable orderly development, it is necessary to limit the drilling in this field to 80 acres per well.

The third phase then of the hearing is to prove to the commission that a well will efficiently recover the oil from each 80-acre tract. Of course, the third phase is where the engineer earns his money. He must fall back on engineering fundamentals and prove that all of the recoverable oil will be obtained by one well on 80-acre spacing.

In this example it may be that there are some other parties interested in the deal that disagree with your recommendations as to proper spacing in the development of the field. In this case, it is likely then that an attorney for the opposition will cross-examine you in an attempt to tear down or to undermine your positive testimony. This is the cross-examination phase of the hearing. After the attorney for the opposition has completed his cross-examination, it is then in order for your attorney to redirect some questions at you in an effort to clarify some of the bad impressions that the opposition may have planted in the commission's mind during the cross-examination phase.

In controversial hearings such as this, the opposition may elect to present testimony. In this case the witness for the opposition will take the stand after all of the witnesses for the applicant have finished and this witness will then present his side of the case. After the witnessses for the opposition have concluded, the attorney for the applicant cross-examines the witness for the opposition and following this, the attorney for the opposition may have some redirect examination of his witness to cover up some of the holes that may have been picked in his testimony. After the parade of witnesses has been completed, the attorneys or the spokesmen for each side sum up their case, much as is done in court. The commission will usually take the case under advisement, take it back to their office, read the transcript that has been taken at the hearing, study it, and in due course make a decision and issue an order.

Proration Importance

It is natural for most people to get the idea that their work is more important than it may really be. I guess that I am no exception because I feel that proration is going to be one of the most important keys to the future success or failure of the oil industry in the United States.

There has been considerable thought the past year or so that the United States has greatly overdrilled its oil fields. With the proration system we have been using—whereby an incentive is given for drilling more and more wells — the result has been that too many wells have been drilled in an attempt to increase or maintain one's position in the limited market for petroleum. The result is that the cost of producing and drilling for petroleum is so high in the United States that we are not competing, economics-wise, with petroleum from the Middle East or South America. One example of this may be seen by the fact that if all of the wells that have been drilled in Texas were evenly spaced, there would now be one well for every 384 acres in the *entire* state. Excluding these counties where no oil or gas has been found, the density would be one well per 250 acres.

Table 3.

	Producing oil wells	Daily production (BOPD)	Production per well (BOPD/well)
Texas	173,959	2,975,000	17
Louisiana	19,968	818,000	41
Middle East (Six Nations)	776	3,505,000	4520

Table 3 also illustrates U.S. overdevelopment as compared with the Middle East. You will note that the six nations in the Middle East produce more each day than Texas with only 776 wells, or ½ of 1 percent of the number of wells in Texas.

To enable our industry to remain healthy and competitive in the future, there must be a proration system that will make it unattractive to want to drill on unnecessarily close spacing. We can legislate all we want to forbidding close spacing, but it won't work until we provide the incentive to do otherwise.

This system must be one that will prevent an operator (not by rules but by economics) from drilling a pool on 40-acre spacing when 1000-acre spacing would do. This same system must also make it unattractive for an operator to *want* to drill on a small tract if such well is unnecessary to produce the reserves from the pool. If we need to drill only a small fraction of the number of wells we do today to get the same amount of reserves, surely we could produce this oil more cheaply.

End of the Fable

Let's finish the fable told at the beginning. You will recall that the first part of the fable told the story that waste was occurring. The rest of the fable could be told like this.

In this land where there were many wise leaders who, upon hearing of the wasteful slaughter of their new-found game, established rules for the hunters to follow. One of these rules said, "For each gun that ye have, ye shall shoot but five birds each day." And so it came to pass that these precious birds were never again needlessly killed and, for a while the people in this land grew stronger and stronger and they were very happy.

Meanwhile, the hunters were buying more and more guns to shoot more and more birds until one day there were so many guns in the land that the wise leader could only say, "For each gun that ye have, ye shall *now* shoot but one bird each day." Again the people of the great land became unhappy and they said unto each other, "What shall we do?"

I wish I could finish the fable for you. Will the last verse present a happy ending or a sad one? Perhaps writing the last verse will be your job. It's a big challenge! ★ ★ ★

The Author

John E. Garrett is senior reservoir engineer in charge of proration and unitization for the Atlantic Refining Company in Dallas, Texas. He received his BS degree in mechanical engineering in 1949 from Oklahoma Institute of Technology of Oklahoma A&M College, and has been associated with the reservoir engineering group of Atlantic since graduation. He is a registered professional engineer and a member of the AIME.

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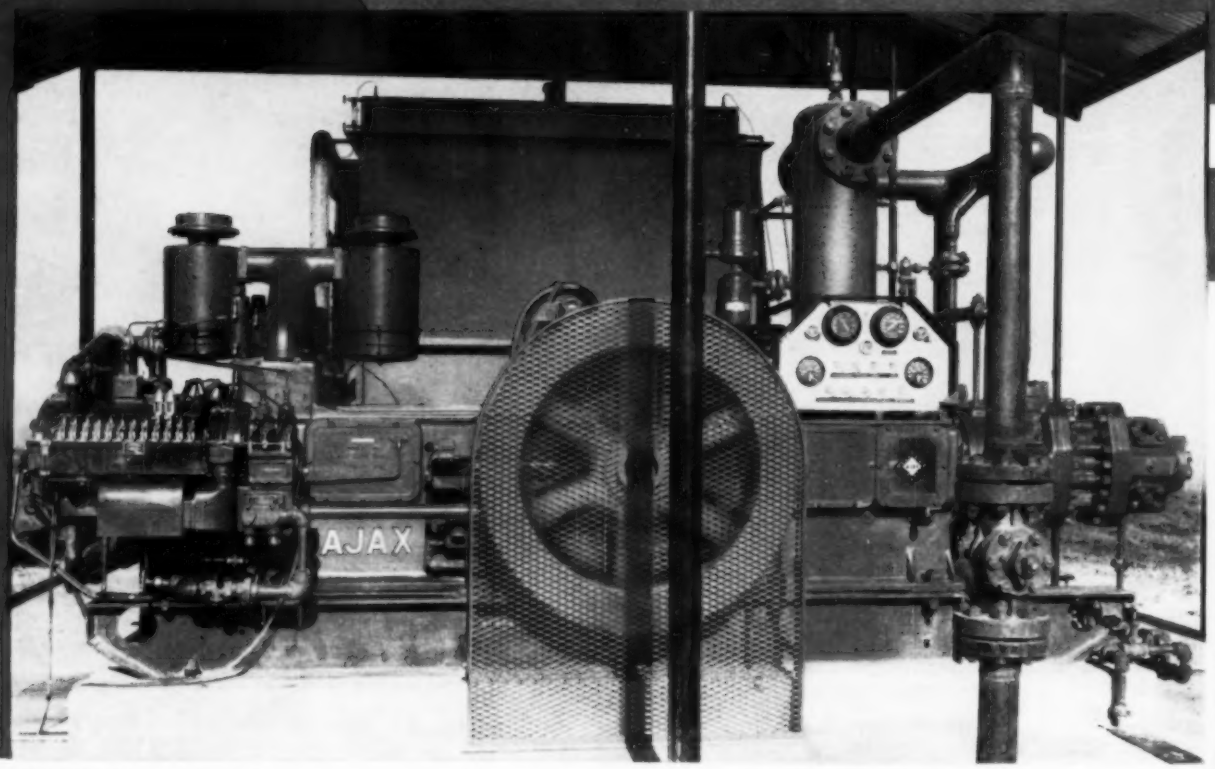

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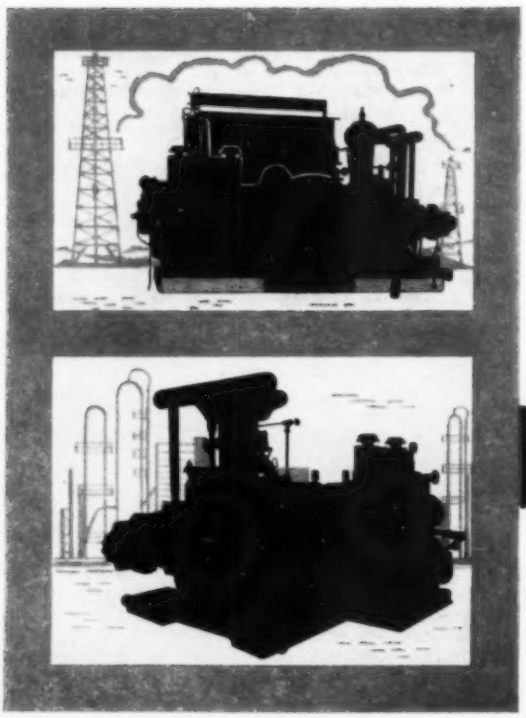

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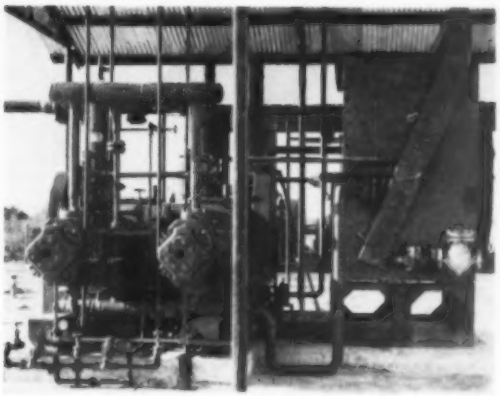
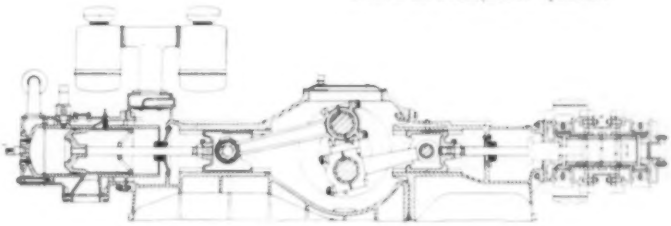
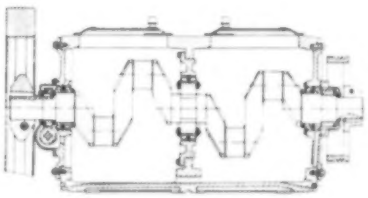


Note convenient accessibility all around both compressor cylinders.





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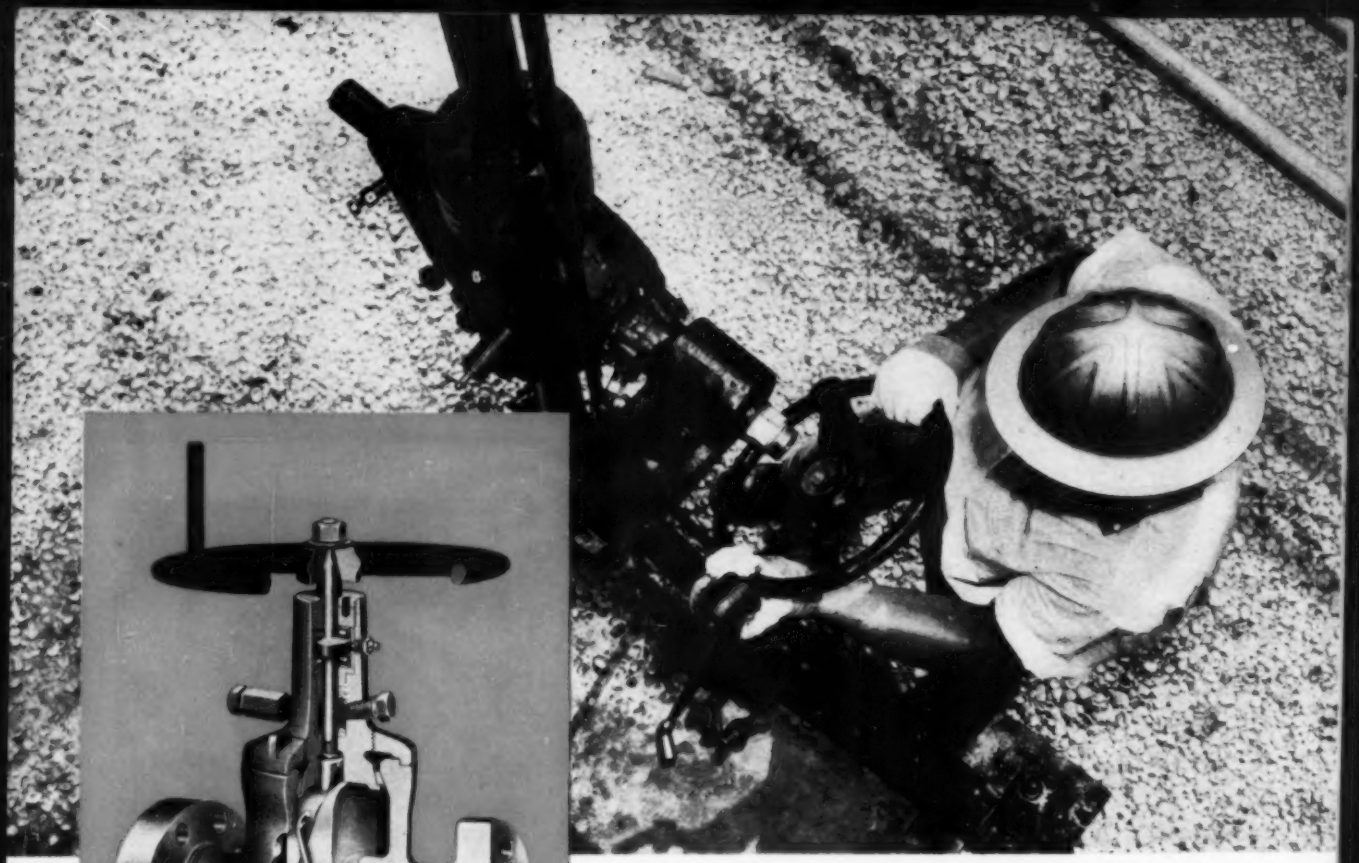

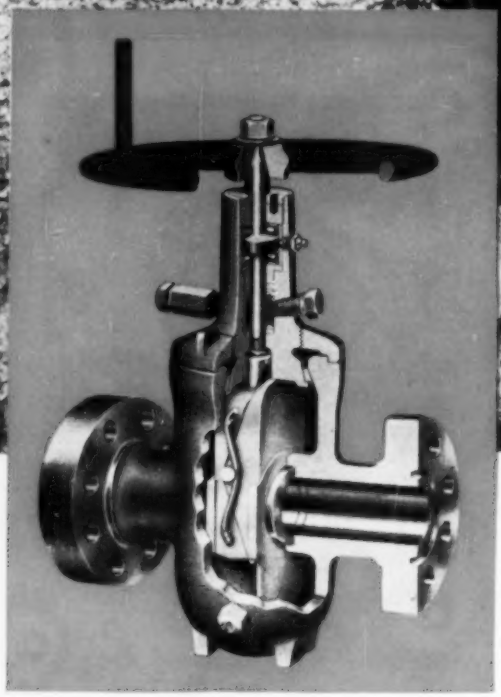

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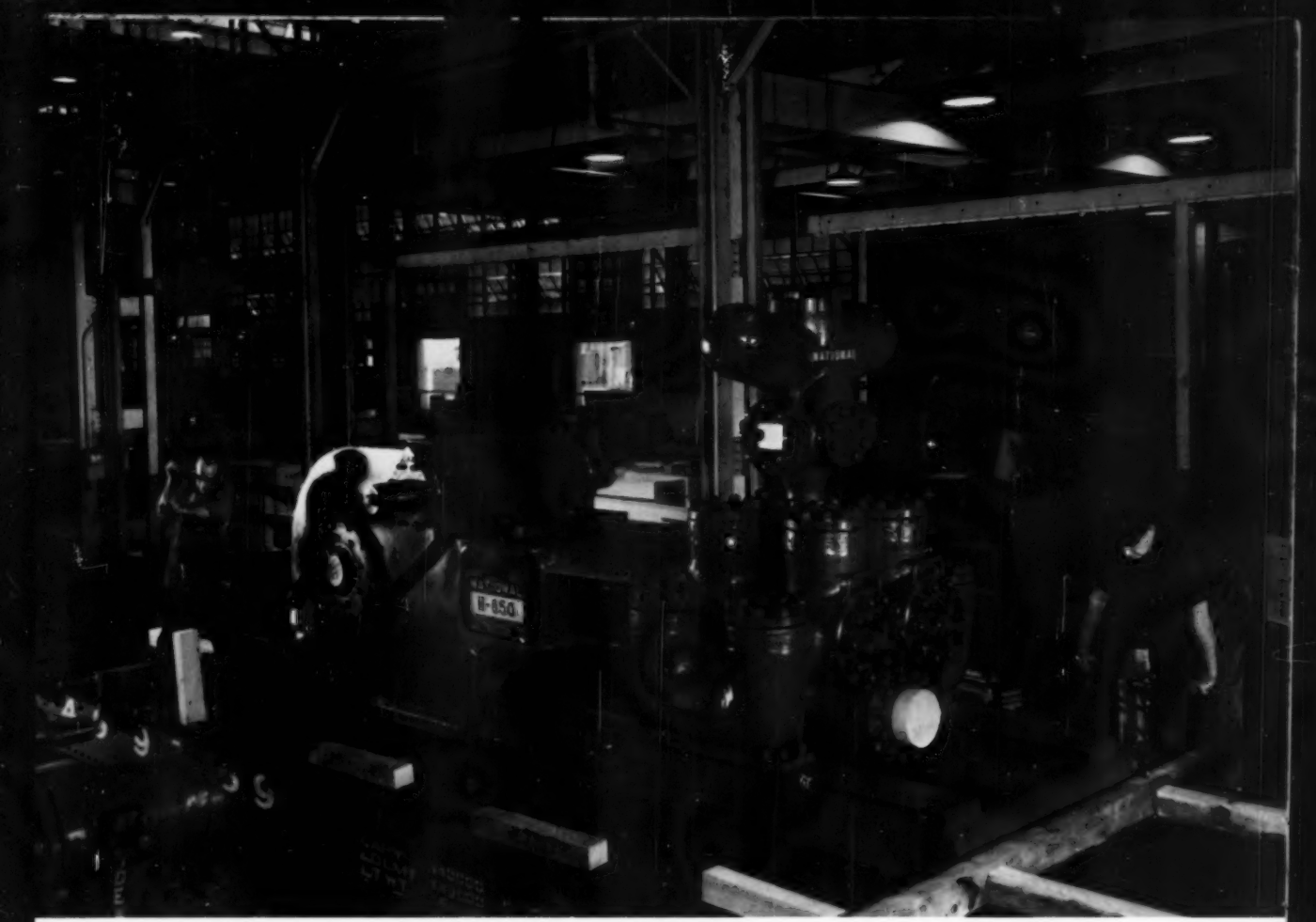

A new H-850 slush pump is prepared for shipment from National Supply's Toledo, Ohio, Plant. The H-850 has a rated input of 850 hp and hydrostatic test pressure of 8,000 psi in the fluid cylinder. Bore is 8" maximum and stroke is 15".

"The new H-850 pump is designed to give longer trouble-free service, under more severe conditions, than any previous National Slush Pump, or any other comparable pump"

That's what the men who have engineered and built this streamlined new pump say about it, and they point to the features of its *uniquely designed fluid end*, as well as many other features, to back up their statement.

More horsepower per unit of weight

The main frame is made of steel plates and steel castings electrically welded into a unit. The fluid end is a one-piece high-strength steel casting with no internal baffles or walls. Overall, these features serve to provide a pump with higher power (rated input of 850 hp), less weight and better portability.

New packing arrangement reduces stress

Fatigue life is improved by holding and tightening the liner packing independently of the liner, so that the packing carries a load only great

enough to seal off fluid pressure. Thus, the stresses created in the cylinder bore by liner packing pressure are no greater than those created by fluid pressure alone. Moreover, the cylinder head bore is packed off at a point well in from the face of the cylinder, which nearly *cuts in half* the length of this bore exposed to fluid pressure. This reduces the stress level in the bore.

Cylinder bore wear reduced

The liner in the H-850 is held in place metal-to-metal between the cylinder head and the shoulder in the cylinder bore. Liner movement is impossible when the cylinder heads are tightened properly.

Liner packing life increased

The liner packing of the H-850 gives longer and trouble-free service because it is never subjected to pressure greater than that which it must seal, and the clearances that it must close remain constant and closely controlled.

Many benefits in "dual cage fluid end arrangement"

This fluid end design permits independent adjustments of liner packing and cylinder head packing, as well as better retention of the liner. It is especially suitable for jet drilling, where operation at near rated pressure is continuous.

Independent adjustment of liner sleeves and cylinder head packing puts the full effect of any necessary tightening on the packing that is leaking. Because tightening force is not transmitted through one packing to another, there is less chance that extruded rubber will make cages hard to pull.

Smooth and highly efficient fluid flow into and out of the cylinder is insured by locked alignment of inner and outer cage openings and valve ports.

A large contact area between liner cage and cylinder head in the H-850 minimizes the possibility of material upsetting or "cold flow," which would allow the liner to loosen in service.

New National Pulsation Dampener, too

Available as original equipment on the H-850 (and suitable for all pumps rated at 500 hp or more), the new National Pulsation Dampener completely eliminates troublesome rubber diaphragms, bags and sleeves. Only rubber element is a simple disc valve which can be easily and inexpensively replaced. This National Dampener operates on rig air supply—no supply of high pressure air or nitrogen needed for pre-charging.

Many other features

Some other outstanding features of the new H-850 pump include: grease packed bearings for clean lubrication without strainers or gear pumps; bearing cavities which can be filled to capacity, so that if the pump is idled for long periods, moisture can't condense on and corrode bearing surfaces; tapered crosshead pins and tapered threads on piston rod connections to crosshead ends.

With all of these reliable design and operating features, it's easy to see why the H-850 can "give longer trouble-free service, under more severe conditions, than any previous National Slush Pump or any other comparable pump." Ask the National representative in your area to tell you more.

New National Pulsation Dampener is available on the H-850. Suitable for all pumps over 500 hp, this dampener contains no rubber diaphragms, bags or sleeves. It operates on, but does not deplete, rig air supply.

National Fluid End Parts

on the next page!

Reduce maintenance costs with National Fluid End Parts

Dual Seal Piston

Incorporates two replaceable piston rubbers, forming an inner and outer seal at each end of the piston. Void between the rubbers allows space for displacement, minimizes damage to piston lips as it enters liner. Heavy fabric section molded into the back of inner rubber dams off extrusion around the OD of hub, and reduces pinching of the rubber. Forged steel hub of piston resists expansion under extreme loading.

Fluid Piston Rod Packing

Fluid pressure actuates the sealing lips. The greater the pressure, the tighter the seal . . . yet the solid make-up through the body of the packing minimizes the danger of overtightening it when it is installed. Rod wear is sharply reduced, because lip pressure is never excessive . . . in fact, it is negligible on the suction stroke.

Fluid Cylinder Liners

The ID of the Nationaloy Liner is case hardened throughout its length to a hardness of over 650 Brinell. Precision honing gives it maximum resistance to wear, washing and abrasion. Outside surface is machined to close tolerances, promoting closely controlled fits which reduce piston and rod wear due to misalignment.

Fluid Cylinder Liner Packing

Resistant to oil, gas, heat and chemicals, National Liner Sleeves provide a perfect seal between the liner and pump bore. They are sufficiently hard to be confined in the packing space . . . preventing excessive flowing and pinching . . . yet they retain ample resiliency for proper sealing action.

"Blue Stripe" and "Blue Chrome" Piston Rods with API Tapers

Have maximum tensile strength and high resistance to impact. Precision ground and polished to reduce wear of both packing and rod. "Blue Chrome" Piston Rods have a super-hard, abrasion-resistant chrome finish which gives added packing and rod life under all conditions.

Type G-1 Fluid Valves and Seats

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A study of the . . .

Effects of Curtailment on Waterflood Recovery

Many operators are convinced that curtailment of oil production has an adverse effect on ultimate recovery in water injection projects. Others think not. Here is an interpretation of the arguments from both sides

Paul D. Torrey
Department of Petroleum Engineering, University of Texas, Austin, Texas

A STUDY OF THE LITERATURE and particularly of the papers on effects of curtailment of oil production on recovery from water injection projects presented at the 1957 Mid-Year Meeting of the Interstate Oil Compact Commission[1] convinced the writer and his colleague, Dr. Paul A. Witherspoon, professor of petroleum engineering at the University of California, that much of the evidence developed on this controversial subject was subject to definite reconciliation if an effort was made to interpret it fairly and constructively. This joint study with Dr. Witherspoon has provided the foundation for most of the conclusions presented in this paper.

Problems Related to Production Curtailment

There are considerable experimental data that support the contention that curtailment of production from fluid injection projects is not detrimental to ultimate oil recovery. Recent work of Rose and Witherspoon,[2] published by the Illinois Geological Survey Division as a part of a series on "Studies of Waterflood Performance" is cited as an example of such data. In contrast, field data, such as cited by Wright[3] and Nelson[4] at the Third Biennial Secondary Recovery Symposium of the North Texas Section of the Society of Petroleum Engineers of AIME, have been interpreted as supporting the conclusion that curtailment of production from secondary water floods damages oil recovery. Similarly, these papers have emphasized that larger oil recovery will be obtained with high injection rates. Such conclusions should not be accepted without recognizing that there are many oil fields with natural water-drives where a curtailment of oil production has improved ultimate recovery significantly. As Dr. Hocott[5] has maintained, there is no good reason to believe that the displacement process per se is any less efficient in a secondary recovery process than in a natural water drive.

It can be understood, however, that the effect of curtailing oil production in an individual waterflood project, located in a reservoir where natural energy has been largely depleted, will be quite different from the pressure maintenance projects. Here the physical conditions are different to those in the natural or augmented water-drive field, where pressure is being maintained, because only part of the oil reservoir is subject to pressure restoration.

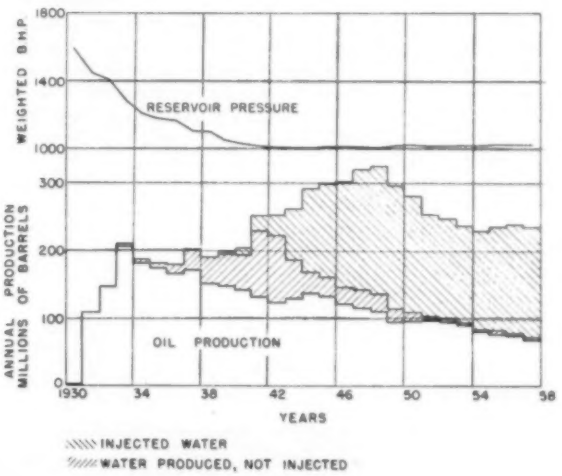
In many oil fields in the United States, where unitization is not possible, the first secondary recovery projects must inevitably be developed and operated adjacent to depleted leases of other operators and royalty owners. Under these conditions line input wells ordinarily will not be drilled.

Under these circumstances, injection operations, obviously, will increase pressures in only a segment of the field. The question then arises as to the effect of curtailing or discontinuing water injection or oil production at or near to the time of peak flood oil production, and after partial or complete restoration of pressure has been achieved in only one part of the reservoir. It is assumed that this would be the most probable time to attempt curtailment if necessary to meet field allowable.

Field evidence presents ample proof that stopping water injection does not necessarily stop the flooding process. Producing wells, if continued in operation, will show a reduction in rate of output, but may continue producing significant quantities of oil and water for several months. Apparently, energy is stored in the system so that fluid movement continues under the influence of diminishing pressure gradients.

Such fluid movement could be definitely detrimental to the operator if oil should be moved outside the developed area of the secondary project. Where no line inputs are protecting the lease boundary, in conformity with procedure enforced repeatedly by the Railroad Commission of Texas, fluid migration across the lease line can eventually take place during normal flooding operations. If migration can occur under these circumstances, why not also at the time of an interruption in the process of water injection?

It is not contended under the conditions just described that the ultimate oil recovery is necessarily reduced for the field as a whole. Rather, it is suggested that a physical movement of oil from one lease to another is quite possible and can result in loss to individual



—Courtesy, W. S. Morris, East Texas Salt Water Disposal Company.

FIG. 1. Graph showing annual oil and water production, water injection, and the weighted bottom-hole pressure at the beginning of each productive year for the East Texas oil field.

Presented at the Petroleum Engineering Conference on Secondary Recovery, sponsored by the Illinois Geological Survey, September 25-27, 1958, University of Illinois, Urbana, Illinois, under original title "Effects of Curtailment of Oil Production on Recovery from Water Injection Projects." The author is chairman of the Secondary Recovery and Pressure Maintenance Committee, Interstate Oil Compact Commission.

operators. It is felt that there can be no disagreement on this point. Such being the case, an operator who chooses to initiate a flood in an otherwise depleted reservoir and cannot use the protection of line inputs, should not be advised that discontinuing or reducing water injection to curtail the peak of oil production will have no adverse effect on the ultimate recovery from his particular lease. Furthermore, if the operator continues to inject water at the normal rate and at the same time is forced to curtail the production of oil, he can be faced with the danger of losing oil irretrievably to adjacent properties.

Definitions

For the purpose of this article the definition of "fluid injection" developed by the Division of Production of the American Petroleum Institute and, subsequently, adopted by the Interstate Oil Compact Commission should be amplified. The API definition is as follows:

Fluid injection is a method of recovery of oil, gas and/or related hydrocarbons in which part of the energy effective in moving these hydrocarbons through a reservoir is applied from extraneous sources by injection of liquids or gases into the reservoir.

Primary pressure maintenance is an application of fluid injection early in the producing life of a reservoir when there has been little or no loss of natural reservoir energy.

Secondary recovery is an application of fluid injection when a reservoir is approaching or has reached economic production limits.

Shortly after these definitions were adopted it became evident that it was not possible in all cases to distinguish easily between pressure maintenance by water injection projects and secondary waterflooding projects. Actually, field experience has shown that there is need for a third, intermediate classification of water injection consisting of pressure restoration in partially depleted fields or properties.

Usually there should be little question about the identification of pressure maintenance projects. They operate in fields where the injection of water into oil reservoirs has been commenced before the bottom-hole pressure has declined below the gas saturation or "bubble-point" pressure, or below the pressure at which the wells will yield their allowable production without the assistance of some form of artificial lift.

Similarly, there can be little question about the positive identification of secondary waterflooding projects. Such projects operate in fields where the average production of the wells has declined to the stripper classification of 10 bbl of oil or less per day.

For the sake of economy, there is a growing tendency to apply artificial water injection to fields where the native reservoir energy has declined to the point where the wells will no longer flow, but which still possess substantial primary reserves. For the purpose of specific identification it is proposed that the API definitions be amplified to classify such operations, which are intermediate between pressure maintenance and true secondary recovery, as pressure restoration projects.

Pressure Maintenance Projects

In fields where natural water drive is being augmented by water injected into the reservoir, curtailment of production from the entire reservoir can have beneficial effects by maintaining favorable mobility relations, by promoting uniformity of water movement throughout the reservoir, and by holding gas in solution for ultimate utilization rather than loss by the waste that usually accompanies uncontrolled production.

There seems to be no valid reason why pressure maintenance projects should not be prorated in accordance with established practice with no danger of loss to the operator and to the state of the income derived from maximum economic recovery of oil. In considering evidence to support this statement no better example can be cited than the production performance history of the East Texas oil field. The oil production from the East Texas field has been prorated in varying extent since shortly after its discovery in 1930.

Commenced originally to dispose of salt water that had become a serious problem of pollution of surface water, the East Texas salt-water injection program has become the most important conservation measure applied to an individual oil field in the United States. Pressure-production performance of the East Texas Woodbine sand reservoir is shown graphically in Fig. 1. Reservoir pressure has remained essentially constant from the first part of 1943 to the present; actually there has been a small increase. It is believed that if the return of a great part of produced water back to the Woodbine reservoir had not been maintained at a fairly constant rate, by 1950 the field would have experienced an additional bottom-hole pressure decline of about 250 psi. This decline would have reduced the pressure approximately to the gas-saturation pressure, and would have resulted in damage to future production possibilities of the field.

Secondary Recovery Projects

Much of the argument over the effects of curtailment of oil production from water injection projects has related to the secondary waterfloods as herein defined. Evidence has already been presented that loss in recovery under certain conditions can take place as a result of curtailed oil production or because of discontinued or reduced water input. This conclusion is based on the fundamental premise that when a pressure differential is created in an oil reservoir movement of fluid will result inevitably. Thus, it is not necessary to debate the interpretation of production curves or the manner of their projection to show that oil can be lost from one property to another. Furthermore, no one is likely to deny the relation between increase in water saturation in the pore system of the reservoir and increase in its permeability to water. Thus, if injected water travels at different rates through the reservoir due to variations in the permeability profile, it will be essential to inject water into the tighter sections of the reservoir so that oil may be produced from them before water begins to move through the more permeable sections at such a high rate, resulting from increased permeability to water, that produced water-oil ratios will increase to an extent no longer profitable. Otherwise the well may be abandoned long before oil can be recovered from the tighter sections of the reservoir. If it were profitable to produce a well at a high water-oil ratio, just as much oil might be produced with low injection rates, but in actual practice such procedure usually will not be economical.

An example of indicated loss in recovery as a result of interrupted water injection is shown in Fig. 2. The statistical data employed in Fig. 2 have been used previously by Earlougher[6] and in part by Jordan, McCardell, and Hocott[7] and have at other times been the subject of considerable argument and discussion. In Fig. 2 the writer shows his own interpretation of the production performance of this project as it has been affected by interrupted water injection. This interpretation is based on extensive experience in the area in which the project is located and on detailed knowledge of reservoir conditions, in addition to a purely mechanical projection of the production decline. Taking all of these factors into consideration the writer concurs with Earlougher's[6] conclusion that there has been a loss in production over a period of about four years of approximately 100,000 bbl of oil. This loss, very conceivably, could be temporary and might be regained if it should be possible to continue to produce the project for an extended period of time which will not be done, in all probability, because it will not be profitable to do so.

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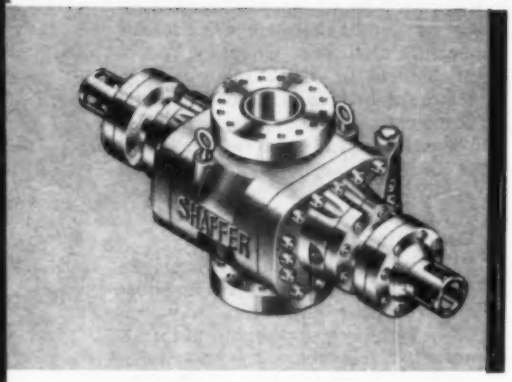

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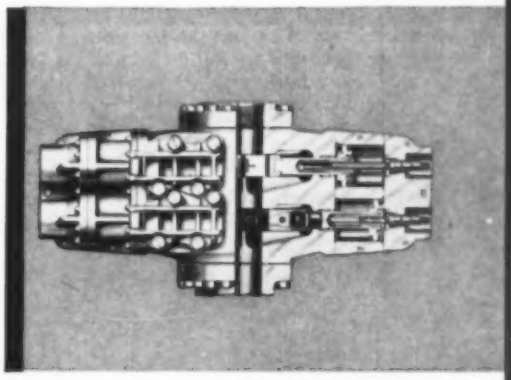

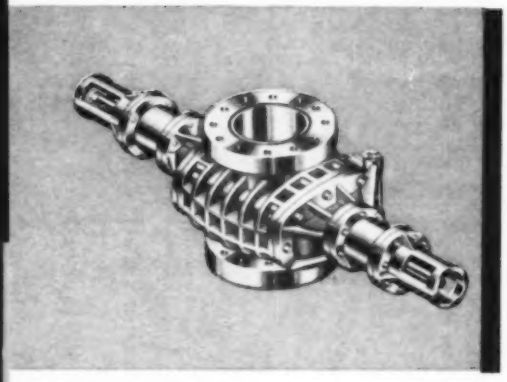

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Pressure Restoration Projects

In recent years it is becoming common practice to initiate water injection operations in reservoirs which still possess substantial reserves but in which pressure has declined below the gas-saturation pressure or below the pressure at which the wells will flow, although they may be capable of yielding several times their allowable production.

Since conclusive evidence is not yet available on the effect of curtailment, George H. Edgerton[8] has suggested that in fields where pressure restoration projects are initiated a limiting field allowable be set at a figure obtained by multiplying the total number of wells in the field by the top allowable subject to shut-down days, based on the average for the preceding year, or using the percentage reduction as applied in states other than Texas. In such instances, no special consideration of increased production resulting from the injection of water would be considered necessary until the predicted rate of production from the pressure restoration project (an advance estimation) reached one-half the difference between the actual primary production and the maximum field top allowable limit. At that time the state regulatory body should hold a hearing to determine whether project priorities should be established in order to limit the rate of development.

Proposed Solution of Curtailment Problem

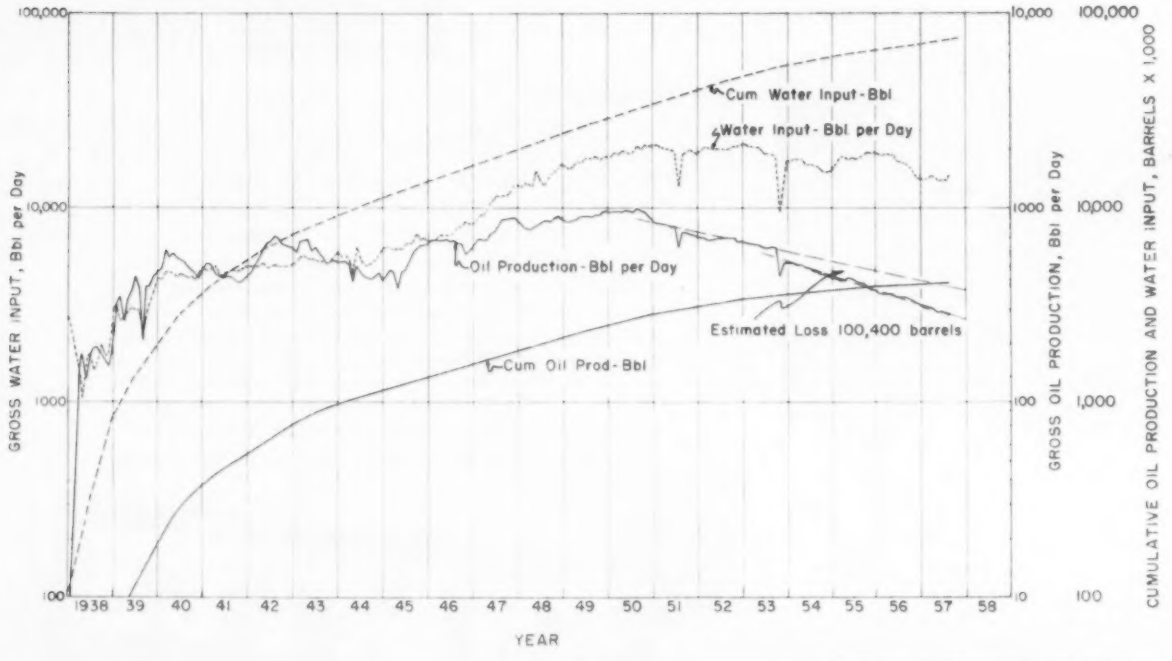
Regardless of personal opinions, it seems certain that some form of curtailment of secondary water flood oil production is eventually inevitable as secondary operations become more and more important factors in the total production of oil in various states. Such being the case, an effort should be made to apply curtailment in a way that will not damage oil recovery which will be to the benefit of both the operator and the state.

The article on "Suggested Administrative Procedure for Stripper Water Floods"[9] by Edgerton and Seydell, presented at the 1958 Mid-Year Meeting of the Interstate Oil Compact Commission, avoided the controversial aspects of the curtailment problem but, instead, proposed a procedure whereby the magnitude of secondary waterflood oil production can be evaluated. This paper purposely did not deal with the mechanics of curtailment and, therefore, for suggestions and for a definite plan as to how curtailment can be applied fairly and effectively, reference is made to a report on "Proposed Basis for Establishing Allowables for Water Floods" by Wallace W. Wilson[10] in March 1956 to the Compact Subcommittee. This report is included as an appendix to this paper with much appreciation to its author.

As can be understood from a consideration of the Wilson report, by limiting the rate of development of secondary waterflood projects, allowable can be maintained within the limit established by the regulatory body, and oil production from individual projects need not be curtailed if the operator, for any personal reason, decides that curtailment will be detrimental to him. Controlled development of water floods has been employed successfully in Pennsylvania, and there is no apparent reason why such procedure cannot be adopted elsewhere with a similar measure of success. By setting appropriate field or district allowables, a regulatory body can control waterflood developments without becoming involved in many disputes that are bound to accompany any attempt to curtail oil production from specific water floods.

Conclusions

In reviewing literature relating to the problem of curtailment, it is apparent that economic conditions have influenced many of the opinions expressed on this subject. It is evident that if most of the projects cited as examples had not been curtailed in one way or another they would have been more profitable. Thus, the profit motive is as important in the development of secondary oil reserves as in the development of primary oil reserves. If the economic factor of time did not reduce income there probably would be little complaint about the damage resulting from prorated secondary oil production.


GROSS WATER INPUT, Bbl per Day
GROSS OIL PRODUCTION, Bbl per Day
CUMULATIVE OIL PRODUCTION AND WATER INPUT, BARRELS X 1,000
Cum Water Input-Bbl
Water Input-Bbl per Day
Oil Production-Bbl per Day
Estimated Loss 100,400 barrels
Cum Oil Prod-Bbl
YEAR
1938 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58

—Courtesy, R. C. Earlougher, Consulting Engineer.

FIG. 2. Production and injection data for 29 leases of Chanute Property Management Corporation, Inc. Waterflood project in Eastern Kansas.

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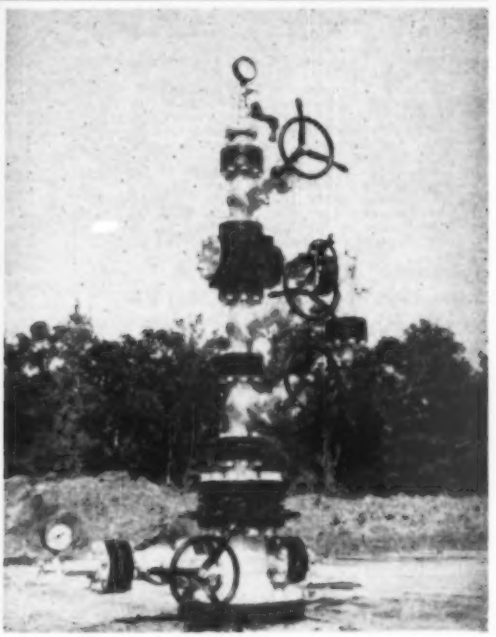

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Furthermore, if it should be possible to produce curtailed secondary water floods profitably over extended periods of time it is likely that the same amount of oil, or even more oil could be produced as would have been the case if production from them had not been curtailed. The difference in the thinking of the operators, of course, is that the uncurtailed projects are usually more profitable than the curtailed ones.

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9. George H. Edgerton and E. Morris Seydell, "Suggested Administrative Procedure for Stripper Water Floods," paper presented at the Mid Year Meeting of the Interstate Oil Compact Commission, Salt Lake City, Utah, June 23, 1958.
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Appendix

Proposed Basis for Establishing Allowables for Water Floods, by Wallace W. Wilson.

The purpose of this proposal is two-fold. First, to outline a procedure for equitably establishing allowables for waterflood projects. Second, to suggest control procedures for bringing waterflood projects within the framework of proration without destroying the efficiency of the flood and on an equitable basis with all other oil producers.

The usual performance of a successful waterflood results in a rapid increase in oil production from each affected well to a relatively high peak rate, followed by a rapid decline with increasing water-oil ratios. The peak rate is a function of several conditions, some of which are under the control of the operator, and others which are not. A summary of the most important factors in each category is as follows:

Controllable

1. Well Spacing or Pattern,
2. Injection Rate.

Not Controllable

1. Pay Thickness,
2. Permeability Distribution,
3. Reservoir Saturation.

In order for an operator to maintain oil production from a flood within a predetermined allowable, he has only the two options of controlling either the injection rate or the well pattern. By either route, then, he can regulate his operation such that the high peak rate for the entire operation is spread out over a longer period of time and at a lower production rate. Most of the opponents of waterflood proration evidently believe that their only recourse is the control of injection rates, and this, they fear, may reduce ultimate recovery. Usually, however, they also have the option of so developing their properties as to cause individual wells to peak at different times, thus maintaining lease production within some reasonable allowable, while operating each producing well at capacity.

It follows that if an operator is to produce within a given allowable by controlling his development rate, the effects of the non-controllable reservoir characteristics on production rate must be determined with some degree of accuracy. This can be done by carefully evaluating a pilot flood, or by projecting the performance of similar reservoirs or nearby leases. Some tolerance factor also must be included in the formula to allow for unpredictable performance.

The nucleus of the proposal which has been worked out is based on the following premises:

1. A water flood is initiated to deplete a part or all of a reservoir, irrespective of the number of wells involved. Allowable should be determined on the basis of area originally committed to the flood plus effective acreage of any new areas subsequently added. With acreage the basis for determining allowables, the operator may drill, plug, or convert wells at his option to increase efficiency and control the flood in accordance with his interpretation of the technological question referred to above.
2. Acreage allowable would be determined by converting the depth bracket allowable or "yardstick" to a barrel per acre allocation on a unit basis. Texas, New Mexico, and Louisiana have such a "yardstick." Sufficient data are available for other prorated states to establish one.
3. Under a firm procedure for determining allowables, most operators will have an incentive to operate their floods through the mechanism of controlled development.

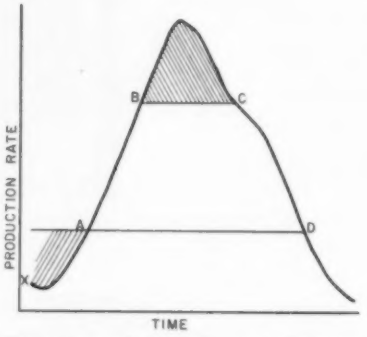

FIG. 3. Proposed procedure for establishing allowables for a water flood. X — Flood initiated. A — Unit allowable calculated on per-acre rate of field under existing proration formula. B — Unit allowable calculated at the per-acre rate as determined by the statewide depth bracket formula or "yardstick" before discount factor, if any, is applied. C — Same rate as at B. At this point, project is designated as a capacity flood. D — Same rate as at A. At this point, project is designated as a salvage flood and is exempted from regulation.

A tentative procedure for establishing allowables for a water flood is as follows: (See Fig. 3).

1. An operator makes application to water flood. (Fig. 3, Point X.) The commission, after hearing, grants a temporary unit allowable equal to the number of acres committed to the flood times the per acre allocation rate of the field under the existing proration formula or yardstick. All oil tendered up to that amount could be run as legal oil. This rate is indicated by Point **A** in Fig. 3. Allowable rate **A** is equitable as between operators in the field. Shut-down days would apply in Texas, and percentage reductions, if any, in other states.
2. When allowable rate **A** is reached or when 18 months have elapsed, whichever is first, a hearing will be called to review the flood. The operator shall furnish the commission data on flood performance to date, his prediction of flood performance for the next 12 months, and his plan of operation to attain that performance.
3. If the commission finds that the operator has a reasonable plan of controlled development or operation, it may grant a new unit allowable up to an amount equal to the number of acres committed to the flood times the per-acre allocation rate as determined by the statewide depth bracket allowable or "yardstick." If this amount is less than the temporary allowable **A**, allowable **A** will prevail. This allowable would be subject to a non-fluctuating discount factor to be determined from the average shut-down day rate for the preceding 12-month period. The undiscounted allowable is represented by Point **B** in Fig. 3. However, this increased allowable would not be made effective until the flood is producing at rate **A** as described in item 1 above.
4. Waterflood unit allowables would be subject to the following provision for over-production: An operator shall be permitted to produce up to 10 percent in excess of his allowable in any one month. Such overproduction shall be balanced off within a period of six months following the month when overproduction occurs. No credit will be allowed for underproduction not resulting from the balancing provision.
5. When a flood is producing at rate **B**, discounted for shutdown days or percentage reduction, it is producing equitably with all prorated wells. Any allowable granted in excess of this rate shall be granted only after notice and hearing before the commission.
6. This proposal contemplates that once an allowable rate is established by the commission it will not fluctuate downward or be reduced for any reason except demonstrated inability to produce or at the request of the operator.

This proposal is presented as one solution to a very complex problem. It has been worked out within the framework of accepted engineering principles and established regulatory practice. Where it was necessary to establish arbitrary values, every attempt was made to keep them at a reasonable level. ★ ★ ★

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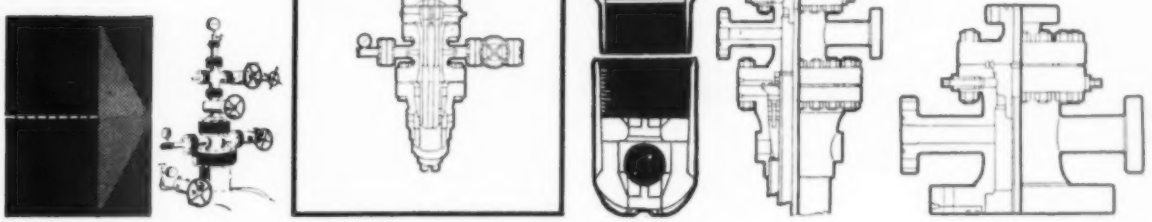

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Equipment used in performing sand consolidation job. Liquid plastic material is pumped from tanks at right down the hole and into the sand-producing formation.

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Field report on a method of...

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Union Oil Company of California has achieved better than 85 percent success in the use of sand-consolidating plastic in Gulf Coast gas producers

George Harper
Union Oil Company of California
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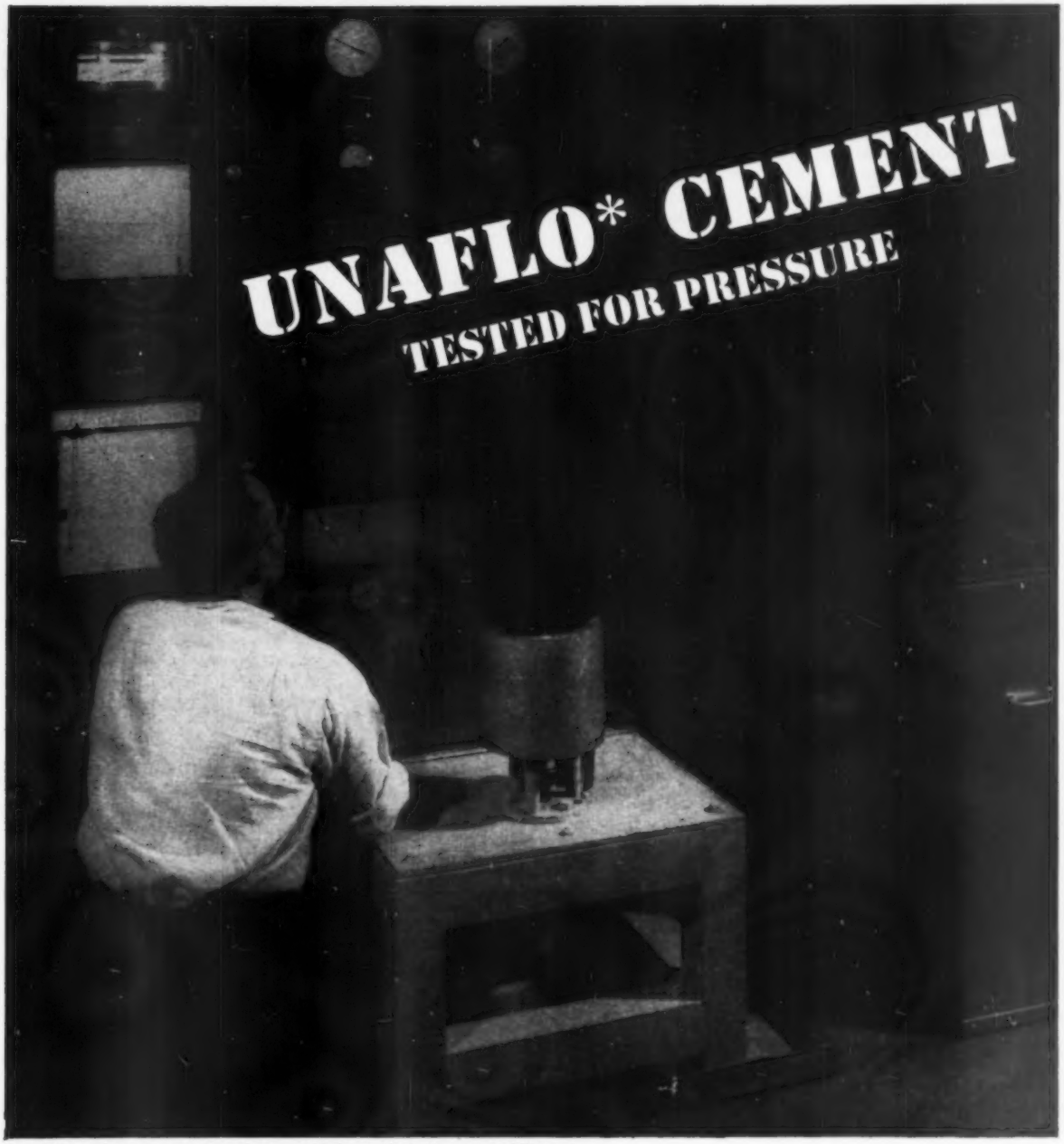
AS A MAJOR GAS PRODUCER in the Gulf Coast, Union Oil Company of California has its share of gas-well sand problems as do all major producers. The problem became prevalent as early as 1952 in the Tigre Lagoon field located in Vermilion Parish, Louisiana. This field, which is typical of most Gulf Coast high-pressure gas fields, was composed of 15 gas wells producing from the Miocene sands at depths of approximately 11,500 ft, with an average surface pressure of 3500 psi. All of these wells were completed with 2½-in. tubing on packers, either of a hookwall or stinger type. Production of the wells was through low-temperature separation equipment, employing diethylene glycol for hydrate inhibition and distillate stabilization.

Sand production was first evident in the gas wells which were structurally low and were producing some 30 to 60 bbl per day of salt water. There was not any large quantity of sand produced, in fact, not enough to form bridges or plug lines. However, high-pressure water knockout dump valve trim life was suddenly reduced from an average of four to five months to less than one month. Sand size was usually 100 to 150 mesh. Several experiments were then conducted in an attempt to find a different dump valve configuration or trim which could tolerate this sand production, but to no avail. By reducing flow rates on the wells from an average of 4,000,000 cu ft per day to 2,000,000 cu ft per day, most of the sand problems were alleviated.

Reducing average take from these wells was not completely satisfactory, however, in that under the terms of field well unitization, equitable production from each unit was required. Hence, Union Oil was faced with a problem which hardly justified a $15,000 to $20,000 workover, but was still hazardous to surface equipment as well as expensive to maintain.

There were several remedial methods which could have been employed for sand control which would in all probability have been successful, but all required rig work which did not seem justifiable at the time. There was only one method which was available that did not require rig work, and which had enjoyed some success in oil wells. This was the use of a sand consolidation plastic material which could be squeezed into the formation through the Christmas tree, without disturbing any of the downhole equipment.

In view of the necessity to maintain production on these wells equitable with the other units, it was deemed advisable to attempt a plastic sand con-



Apparatus used to cure cement specimens used in heat of hydration, permeability and absorption tests. Pressure vessel in foreground simulates these well conditions: temperatures from 80° F. to 400° F. and pressures from atmospheric to 10,000 psi.

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solidation job before resorting to workover. The first well was a typical example of wells in this field with pertinent data as follows: Name, Unit No. 9-1; depth, 11,655 ft; perforations, 17 ft open; tubing, 2½-in.; hookwall packer set at 11,605 ft; tubing flowing pressure, 3450 psi; gas rate, 4000 Mcf per day; distillate rate, 70 bbl per day; water rate, 60 bbl per day; bottom-hole pressure, 5000 psi.

The well was squeezed in August 1952 with 200 gal of sand consolidation plastic in accordance with the service company recommendations. Lease distillate was used both to check the ability of the formation to take fluid and to squeeze the plastic into the formation. In order to compensate for any mistakes in measurements and to avoid leaving plastic in the casing or tubing, a 2-bbl overflush was employed. Breakdown squeeze pressure was considerably below the normal surface pressure due to the hydrostatic head exerted by the column of distillate. However, calculations showed that bottom-hole pressure necessary for breakdown was 500 psi over normal. The 200 gal of distillate were then displaced and, as the plastic started into the formation, an increase of some 2500 psi over normal bottom-hole pressure was required to complete the displacement. No packer leakage trouble was encountered, even with these high squeeze pressures. Facilities were available to put pressure on the casing if squeeze pressures over 3500 psi were required. The well remained shut-in for 24 hours to allow the plastic to set up before attempting to place the well back on production.

After the required 24-hr shut-in, surface pressure had built up from 3000 psi at the completion of the squeeze, to 3500 psi. The well was then turned back into production facilities and no trouble was encountered in resuming production. After the well had cleaned up, it was noted that tubing flowing pressure had decreased 150 psi from a normal of 3900 psi at the required flow rate of 4,000,000 cu ft per day. Water rate on this well had decreased from 60 to 30 bbl per day with no indication of sand production. The decrease in water rate was temporary, however, and within 30 days was back to 60 bbl per day.

Trim life on the high-pressure water knockout was immediately improved from less than one month to over four months. Production of this well was maintained at desired levels for 16 months before a workover was necessitated for reasons other than a sand problem. Water production during the interim had increased from 60 bbl per day to some 300 bbl per day without a sand problem.

Based on the success of this well, other problem wells were soon given the same type treatment. To date, wells in three different fields have been given the same type sand consolidation treatment with better than an 85 percent success ratio. For further study, Table 1 shows a breakdown by wells of the sand consolidation jobs which have been performed in the fields.

Of these 17 wells, there was only one complete failure which required a workover. That was on Unit No. 15-1 which failed to resume natural flow after the required 24-hr shut-in period. Wireline tools revealed a bridge at 11,411 ft, some 100 ft off bottom. Tubing was pulled and a hard plastic bridge was found in the tubing string above the packer. Investigation into possible errors in displacement or faulty plastics failed to reveal any cause for this failure. Shortly after placing this well back on production, from the same horizon,

TABLE 1. Squeeze Data.

Date	Well	Producing depth	Ft of perforations	Breakdown pump press.	Squeeze pressure	Final squeeze pressure
Tigre Lagoon Field						
8-52	9-1	11,516	8	1300	3300	3000
3-53	4-1	11,667	7	1700	1700	1700
*5-53	12-3	11,672	10	3500	3500	3500
7-53	13-2	11,507	10	3500	3500	3500
**2-54	6-1	11,502	22	1100	1250	1250
4-54	15-1	11,516	8	800	800	1000
***12-54	15-1	11,516	8	1900	1900	2000
1-55	15-1	11,516	8	700	600	700
2-55	6-1	11,502	22	1100	1100	1250
12-55	5-1	11,665	15	1425	1425	1425
8-56	14-1	11,179	28	1600	1600	2100
10-56	13-2	11,264	10	1400	1400	1550
****5-58	7-2	11,508	45	500	200	0
Houma Field						
2-54	2-1	10,315	7	1100	1000	1300
1-56	14-1	10,035	20	900	800	950
11-56	3-1	10,250	14	900	900	900
10-56	7-1	10,094	4	200	0	200
West White Lake Field						
7-56	11-A	10,673	20	2100	3900	3900
3-57	2-A	8,628	10	1600	1600	900

*Not successful.
**Sand production stopped for only 12 months at which time another 200 gal stage successfully restrained sand production.
***Used only ½ batch (100 gal) which was not successful. Resqueezed with second ½ batch successfully.
****Used one and one half batches (300 gal) because of large number of perforations open — job successful.

TABLE 2. Well Performance.

		Tubing flowing pressure		Water prod. in B/D				Life of squeeze in months as of 8-58
Date	Well	Before	After	Before	After	Present*	**Workover date	
Tigre Lagoon Field								
8-52	9-1	3900	3750	60	20	300	1-54	17
3-53	4-1	3800	3500	60	120	1300	12-55	32
5-53	12-3	3800	3550	40	97	250	4-54	11
7-53	13-2	3800	3650	61	10	400	3-54	8
2-54	6-1	3650	3575	67	17	200	Resqueezed	12
4-54	15-1	2500	None— Well failed to flow—Tbg. plugged—Worked over.					
12-54	15-1	2500	2500	110	33	Not successful		
1-55	15-1	2500	2500	110	110	1300	7-56	18
2-55	6-1	3250	3000	200	228	380	11-55	9
12-55	5-1	3800	3650	160	225	1160	None	32
8-56	14-1	3800	3750	38	12	105	None	24
10-56	13-2	3750	3750	19	4	2000	11-57	13
5-58	7-2	2500	2025	420	350	420	None	3
Houma Field								
2-54	2-1	3500	3100	117	117	220	11-56	33
1-56	14-1	3600	3505	0	0	7	None	31
11-56	3-1	3050	3050	8	3	3	None	21
10-56	7-1	2500	2500	262	240	950	6-58	20
West White Lake Field								
7-56	11-A	3000	2900	22	27	400	None	25
3-57	2-A	2400	2400	648	245	1500	None	17

*Or prior to workover.
**For reasons other than sand production.

MR. L. F. McCOLLUM,

President Continental Oil Company

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"In the complex structure of the oil business, *each* function is vitally important. The most important thing, it seems to me, is that our industry continues to provide the American public with energy in forms which contribute to our citizens' greater mobility, production of goods, comfort, and national defense.

"Oil men are risk-takers. The people who manufacture and sell equipment, service rigs, and do the actual drilling — they're risk-takers, too.

"The supply industry has played some long odds — and with about the same results the other segments of the industry have had in terms of successes and failures.

"My hat's off to the supply men. They supply first-class service to the men on the rig and to the men on production leases. And that's a genuine contribution to the success of our industry in its big job of serving the public."

P.E.S.A.*

* PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

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sand production again became a problem — so serious that it was imperative something be done. In view of the fact that this well had only 5 ft of perforations open, it was decided to try a half-batch plastic job of 100 gal, with a 4-bbl overflush. This job was performed and was only partially successful. Another half-batch squeeze was performed and proved successful. Production was maintained on this well at desired levels for 18 months, with water rates up to 1300 bbl per day, before a workover was necessitated for reasons other than sand.

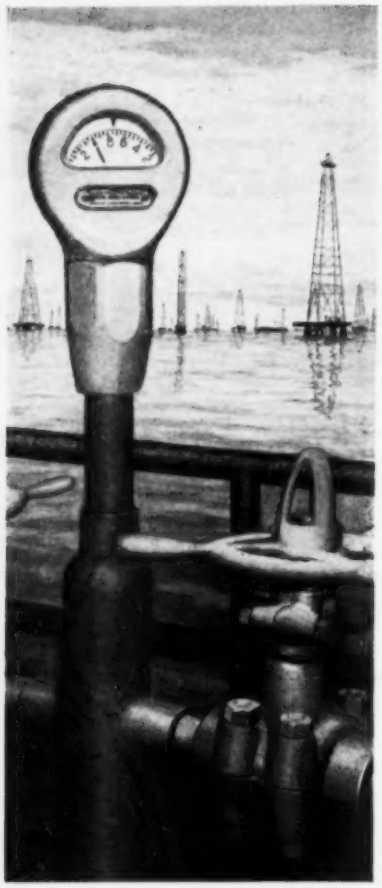
On all but two of the tabulated wells, single-stage (200 gal) plastic squeezes were adequate to control sand sufficiently. In two other cases, a second stage was required before the wells remained sand-free.

Table 2 gives a well history on all of the wells which have been squeezed to date. It is noted from the table that sand-free production was maintained on wells producing over 1000 bbl of salt water per day, over a two-year period. From past history, it is expected that before all of these wells are depleted, it may be necessary to plasticize periodically for sand control.

Further study of well performance after squeezing reveals that in most cases tubing flowing pressure decreased slightly after squeezing; therefore, it stands to reason that permeability was affected to some extent. Salt-water production greatly decreased in some instances, but within 30 days the rate was equal to or greater than the rate before squeezing. This indicates that most of the plastic was absorbed into the more permeable water section of the producing interval.

The average plastic-consolidation squeeze costs $1800 per well, which is paid out in savings in water dump valve trim alone. Other economic factors include lower maintenance cost required to maintain the wells, in addition to added safety.

The Union Oil Company has found sand consolidation plastic an economic solution to the sand problem in gas wells. Success ratio is high and there is no indication that reservoirs are damaged through the use of these plastics. By this means, wells have been depleted without resorting to expensive remedial measures. Required flow rates have been safely maintained through high-pressure equipment while handling as much as 1000 bbl of salt water per day. This remedial measure is now considered standard procedure for such sand problems; in fact, a well is squeezed as soon as trouble is encountered, since it is felt that a more lasting job can be obtained if the job is performed prior to abundant sand production. ★ ★ ★



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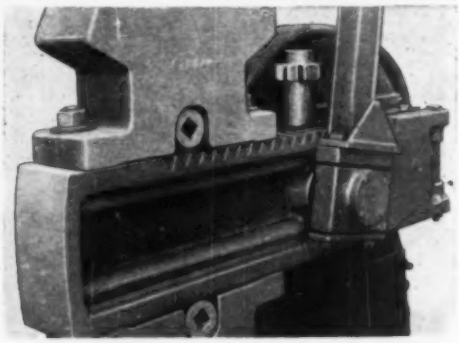

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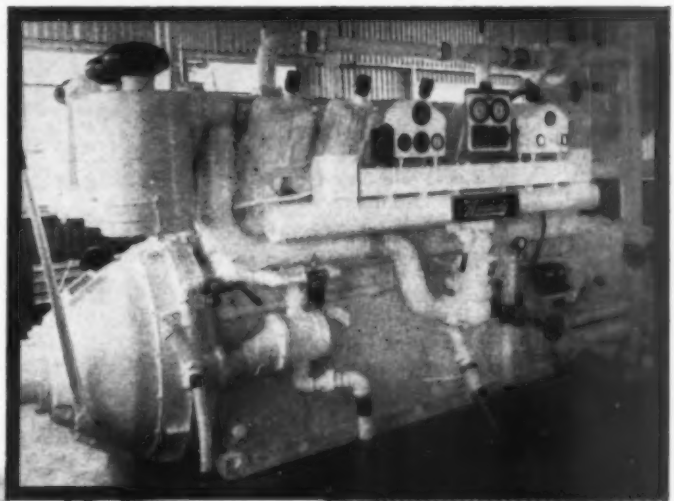

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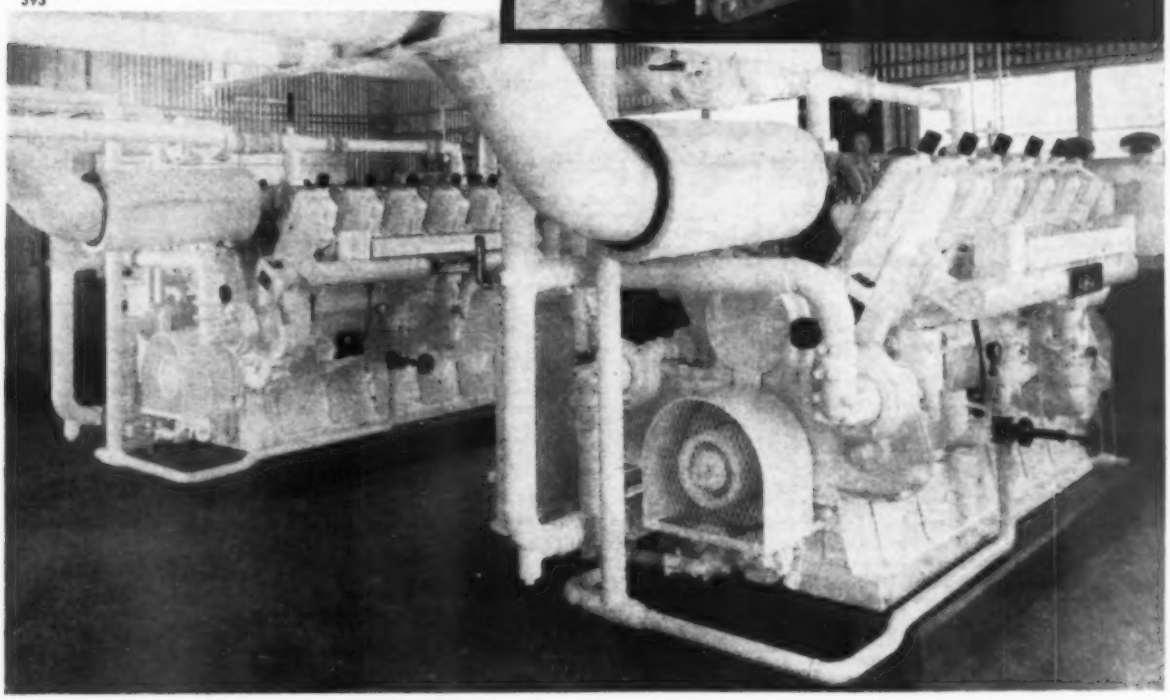

Petrofina Hits in Portuguese West Africa

Exploration and Exploitation in Angola

Two fields developed; PETRANGOL completes 13 producers from 37 tests; several structures yet to be drilled

Francois de Boulard
Manager, Exploration Department
Petrofina S. A.

OIL EXPLORATION in Angola, in West Africa, below French Equatorial Africa and Belgian Congo, is carried by the Petrofina Group in a concession of 14,000 square miles covering the sedimentary formation along the coast of Angola between the Delta of the Congo River to the North and the city of Novo Redondo to the South.

The concession covers the two main sedimentary basins: The Portuguese Congo-Zaire Basin, which is the southern part of the geological unit including French Equatorial Africa and Cabinda, and the Cuanza Basin with the Cuanza River in its center (Fig. 1).

In March 1953 a contract was signed in Lisbon between the Portuguese Government and Companhia de Combustiveis de Lobito (Belgian Petrofina's Portuguese affiliate) granting to the company the exclusive rights for prospecting and exploring for oil and gas discovered in the concession. Operations were to be conducted by a mission organized and managed by Belgian Petrofina.

Seismic work was started in July 1952 with one crew which was joined by a second one in 1953. They covered 14,000 miles of profiles up to end 1957 mostly in the Cuanza Basin, north to the Cuanza River. In addition, in 1957 a marine survey was carried along the coast of the Cuanza and the Portuguese Congo Basin, covering about 600 miles of profiles.

The seismic party is now exploring the part of the basin which extends south of the Cuanza River, at an average rate of 100 miles per month. Then it will be transferred to the Congo-Zaire Basin.

Drilling closely followed the seismics and the first well was spudded in December 1952 at Sao-Tiago, 40 miles north of Luanda.

There are now four rigs in Angola drilling in the concession: 2 heavy, one medium, and one light.

37 Wells

In the favorable zones, selected north of the Cuanza River (Fig. 2) 9 structures have, up to now, been drilled. Two have been proven commercially exploitable, a third recently gave encouraging results in initial production tests.

Altogether 37 wells — up to 12,000 ft—have been drilled. Some 13 are producers—7 at Luanda and 6 at Benfica. The first one in Cacuaco is under prolonged production test.

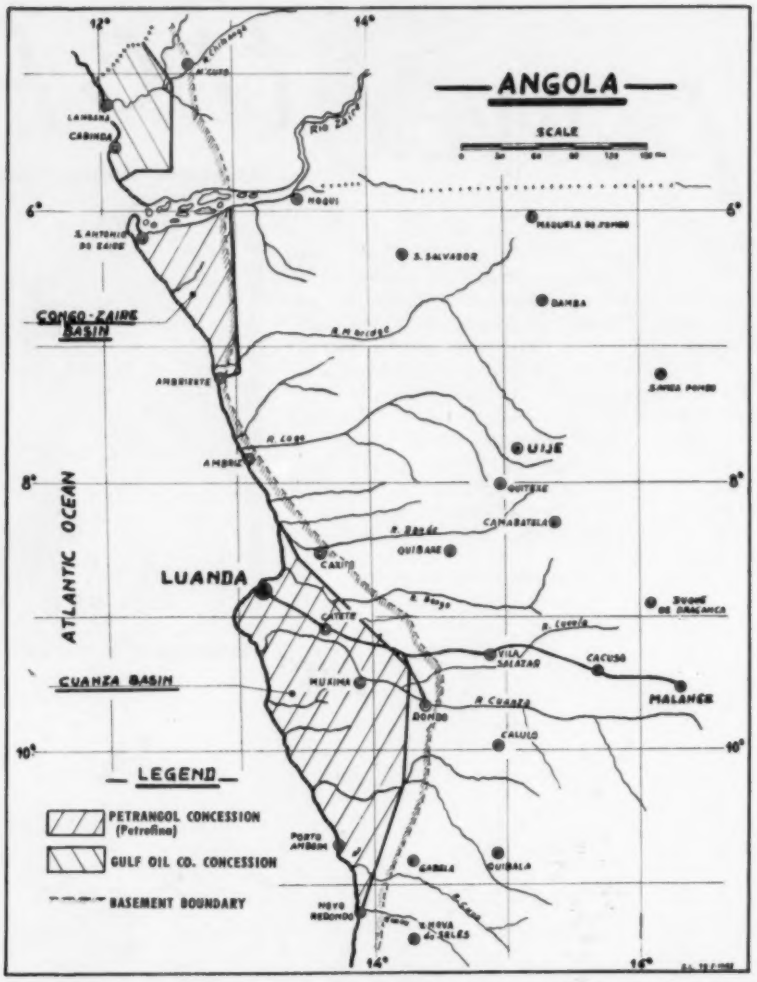

FIG. 1. Petrofina is exploring oil potential of its 14,000 square mile concession along the coast of Angola in West Africa. Seismic parties are still active in the permit area, with drillers following close behind. Two fields are in development stages.

Total footage drilled up to the end of 1957 amounted to 230,000 ft of which 200,000 were drilled in 1956 and 1957.

Drilling has started south of the Cuanza River on the Longa structure, about 130 miles south of Luanda. Some shows of oil have been encountered in drilling below 7500 ft.

Several structures—some of them

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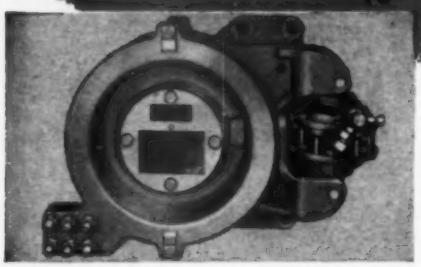

MARTIN-DECKER *is now offering the Type "FS" Weight Indicator with the famous Sensater replacing the piston as the sensing element. This gives the "FS" all the advantages of its bigger brothers—the "E" and "D" Weight Indicators.*

THE SENSATER realizes every weight change no matter how small and relays it instantly to the Indicator mounted conveniently in front of the driller. At medium depths small weight changes are very important and must be known for best operation. It is in the medium range that competition is extremely strong and footage rates cut to the barest margin of profit. A rig operator cannot afford any unnecessary loss of time and must make the best use of all drilling time. The Type "FS" is the best insurance against lost time due to fishing jobs, giving him quick and better recovery. The sensitivity and accuracy in this instrument will give the best use of all drill collars run . . . and faster, better hole.

The anchor installation provides a quick, easy method of slipping the line and because the Sensater is an integral part of the anchor there is no need to move the pressure transformer during the operation — thus preventing one of the major causes of Weight Indicator damage.

The indicator has a net weight on bit pointer and dial that is extremely helpful to the driller in maintaining a constant bit weight. Experience has shown this instrument to be accurate and dependable for many years of trouble-free operation.

THE ANCHOR—The Type "FS" Wire Line Anchor is manufactured by the National Supply Company. It is similar to the "E" and "D" anchors with the exception of being lighter, smaller and designed for side mounting. It provides a simple, convenient method of slipping the line and does not require the removal of the Sensater.

THE SENSATER — The Sensater sensing element in the "FS" is a smaller edition of the one incorporated in the "E" and "D" instruments and offers all the advantages of the larger cell. This new addition to the "FS" instrument makes it even more attractive to the operator who desires a sensitive, accurate weight indication at low cost.

THE GAUGE — The Type "FS" gauge is equipped with a total load pointer and a four-to-one vernier pointer for extra sensitivity. There are also two dials: the inner dial, reading in pounds or kilos, for the total load and the outer dial is adjustable to enable the operator to read the weight on the bit or the net pull on the pipe when fishing or in a tight hole.

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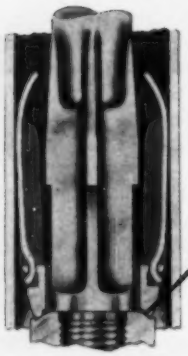

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very large—have been detected by the seismic survey south of the Cuanza River.

According to contract terms of the concession, as soon as the economical exploitation of an oil discovery was established, all rights have to be transferred to a new company. Under certain provisions of the contract, the Portuguese Government is to receive free, one third of the shares of the new company.

The commercial potentiality of Benfica and Luanda oil fields being proved, "Companhia Concessionaria de Petroleos de Angola" (PETRANGOL) was founded in Lisbon in October 1957.

PETRANGOL has received all exclusive rights for exploring and exploiting oil production on the referred concession according to the 1953 contract.

To make the most of proved oil production in existence today, a topping unit with a capacity of 700,000 bbl per year was recently erected by PETRANGOL in Luanda.

The installation was put onstream in April and is selling commercial finished products, namely gasoline, gas-oil and fuel-oil to local marketing companies.

Present rate of production of the Benfica and Luanda fields is about 1800 bbl per day with all wells flowing. ★ ★

The Author

Francois de Boulard *is manager of the exploration department of Petrofina S.A. and coordinates the Group's intercontinental exploration and production activity. Before World War II, he worked in Kansas. After the war, he joined Regie Autonome des Petroles as manager of exploration.*

Later he went to Algiers as manager for Algeria of RAP's affiliate, Cie de Recherches et d'Exploitation du Petrole au Sahara (CREPS) before joining Petrofina in 1956.

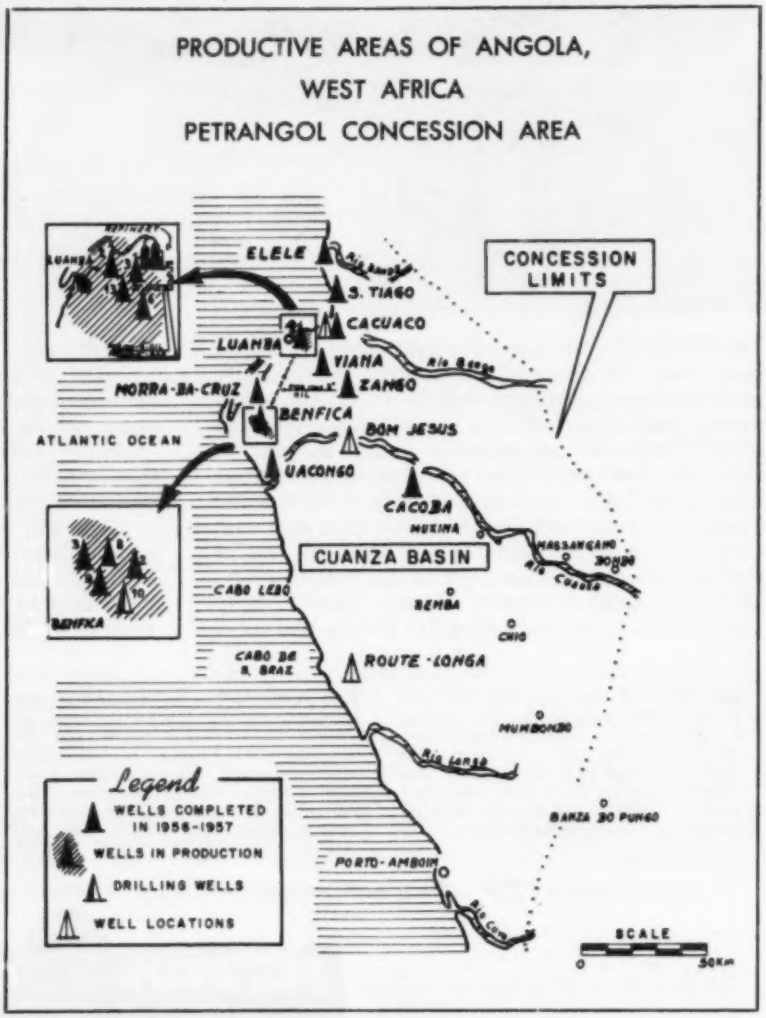
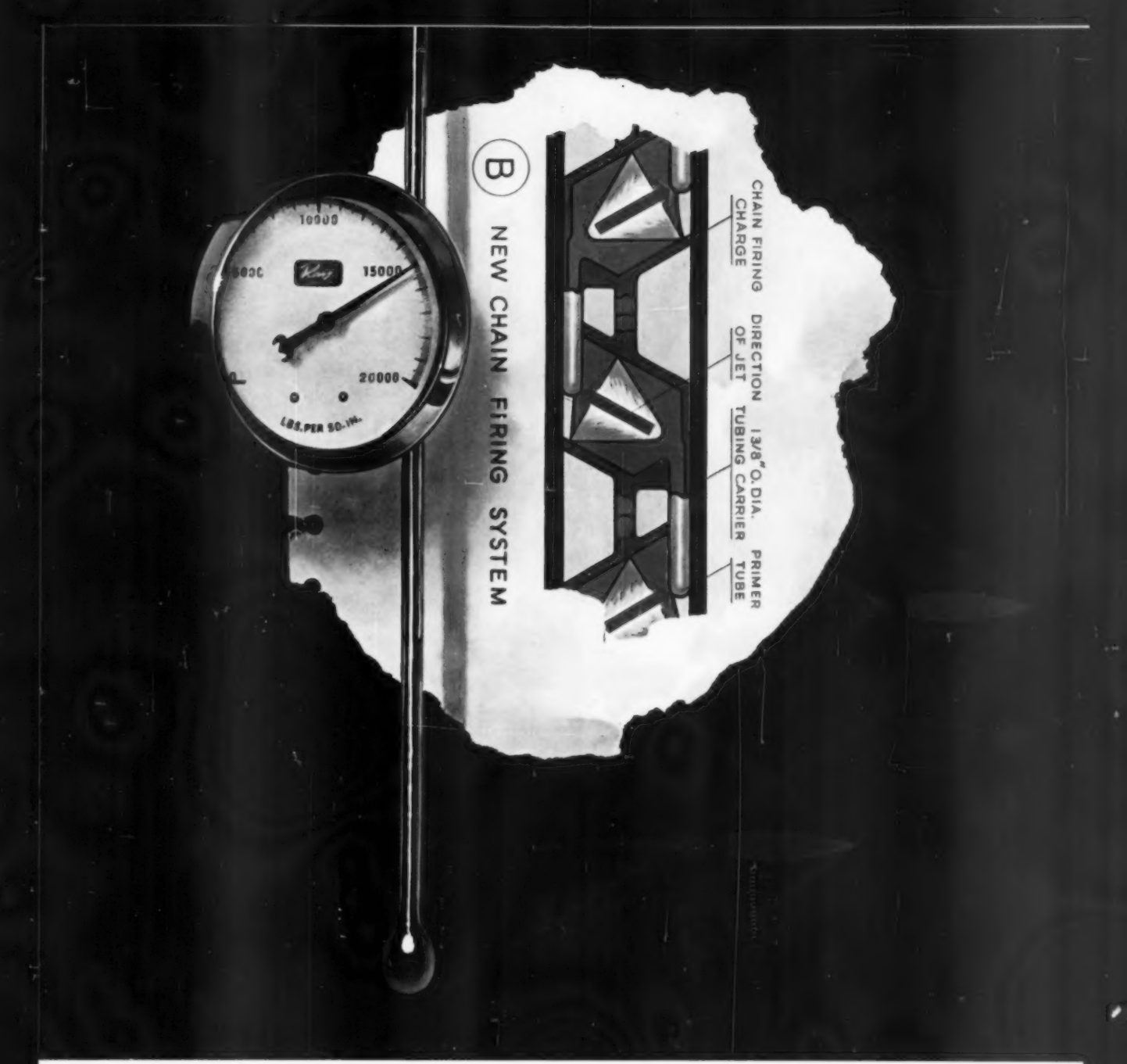


FIG. 2. PETRANGOL, in addition to drilling wells, has also built gas and crude pipelines and has in operation at Luanda a topping plant of capacity: 700,000 bbl of crude annually.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



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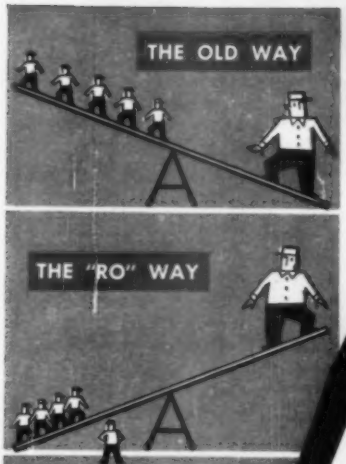

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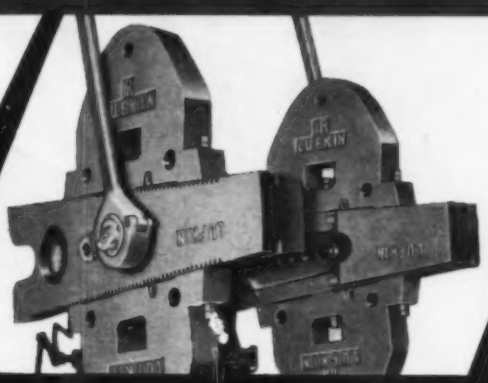
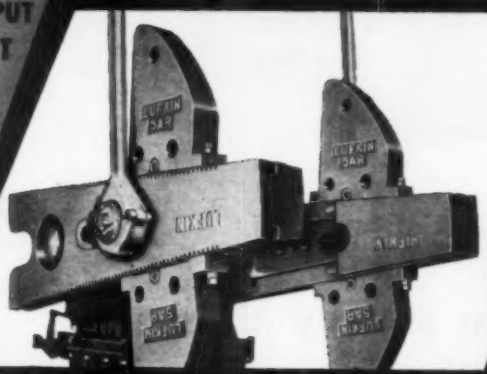


Larger counterweights for above average requirements. Increased thickness at end of crank for extra counterbalance.



Smaller counterweights are interchangeable on the same cranks for reduced counterbalance requirements.

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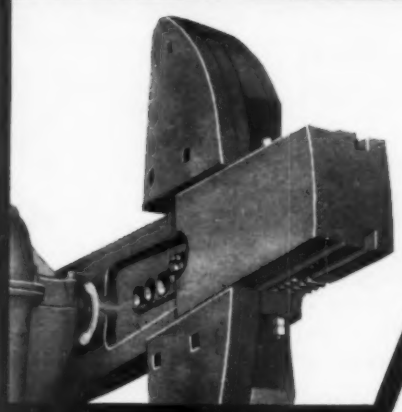

Extra space for thicker weights allows greater weight concentration at outer end of crank. Thick or thin auxiliary weights for greater counterbalance flexibility.

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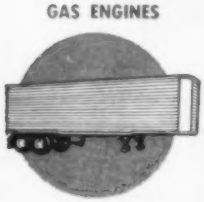
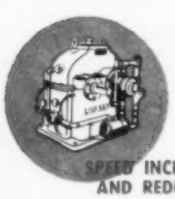


TRAILERS



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New development makes it economical to . . .

Plug Back Casing Without Removing Tubing

Host of field jobs demonstrate practicability of a new drillable through-tubing bridge plug. Cement is spotted by a wire line dump bailer with a full opening bottom electrically released

L. W. Toelke
Great Lakes Petroleum Service, Inc.
Houston, Texas

COMPLETE REMEDIAL casing plug-back and perforating jobs have been performed in relatively deep wells in the Gulf Coast in less than 30 hours . . . without the use of a rig and without disturbing the tubing-packer setting. Savings over conventional plug-back operations on land locations in the 10,000-ft depth range amount to from $3000 to $4000; on water locations, savings range up to $6000. Wire line, through-tubing plug back jobs can be done under pressure with lubricators and adequate wire line blowout prevention equipment, but require slightly more time than similar jobs on wells with little or no surface pressure.

Key to this new casing plug-back idea is the development of a completely drillable, all-aluminum, through-tubing casing bridge plug. It is only 1-11/16-in. outside diameter and will pass freely through 2-in. ID tubing. It is expanded or "set" by a small controlled propellent charge. A wire line, through-tubing dump bailer equipped with an electrically-released, full opening bottom facilitates the placement of cement on top of the bridge plug. After the cement plug has set, a retrievable swing-jet perforator designed to pass through tubing is used to perforate the well.

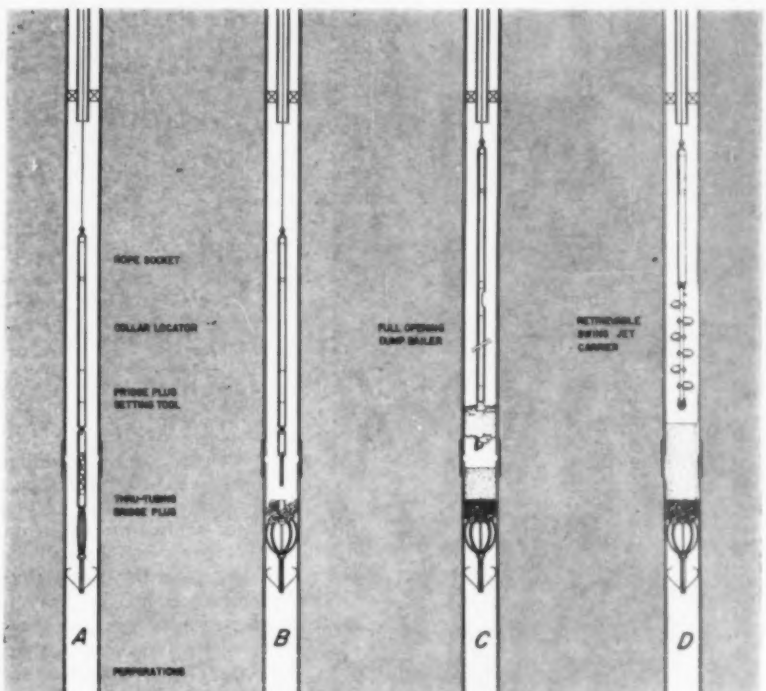
Basis of development. Plugging back a well through tubing in 5-in., 5½-in. or 7-in. casing where the depleted zone is 500 to 2000 ft above bottom normally requires excess casing fillup. When more than 50 ft of casing fillup is required, the job becomes both costly and time consuming. A casing bridge plug that could be placed at any point below the tubing and without disturbing the tubing-packer setting was developed.

How the plug works. The through-tubing casing bridge plug is all aluminum, 1-11/16-in. outside diameter. Surrounding a main tension mandrel are several ribs which are forced into tight frictional engagement against the walls of the casing by a propellent. When actuated, the aluminum body "clusters" inside the casing to form the bridge.

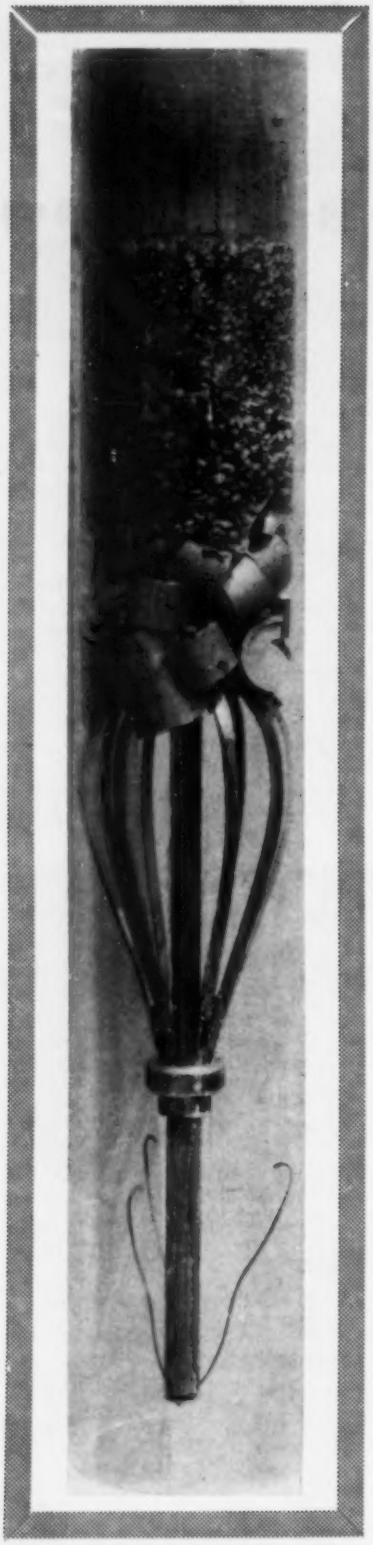
The propellent is contained and ignited in a separate setting tool above the bridge plug. When the tool is actuated, the upper housing is driven downward to a point of engagement and is locked to the mandrel. The setting tool then releases automatically and is withdrawn from the well.

The purpose of this type bridge plug was to overcome many of the problems and expense encountered in former methods when it was desired to plug back without disturbing the tubing-packer setting. Similar jobs have been done with a solid wire line permanent completion[1] unit which uses an aluminum telescopic tail pipe extension that lands on a seating nipple in the tubing string above the packer. Cement is pumped down the tubing and out the end of the extension pipe to form the cement plug. It was necessary to fill up the hole below the point of plug back. This new through-tubing plug eliminates any excessive fillup when the plug-back is to be located above bottom.

Purpose of this through-tubing type plug is to form a solid base which per-



Wire line plug back above perforations. (A) Through-tubing bridge plug run in well below setting tool and collar locator and spotted several feet below collar; (B) Bridge plug is set, setting tool and collar locator withdrawn; (C) Full opening bottom dump bailer places aggregate and cement on top of bridge plug to form casing cement plug. Well is then perforated by through-tubing retrievable swing jet perforator (D).



Through-tubing bridge plug set in 5½-in. plastic pipe to clearly demonstrate bridging action by "cluster" body held in position by friction against walls of pipe. Aggregate and cement on top form the casing plug. The all-aluminum assembly can be drilled easily.

mits dumping and retaining other aggregate and cement. The bridge plug itself does not form a pressure seal such as a typical casing bridge plug, but rather forms a support for the cement or plastic column placed above it. It is this column that forms the seal and strength of the plug-back.

Wire line dump bailer. After the plug has been set, a cement slurry is mixed, loaded into the through-tubing dump bailer and lowered to the bridge and dumped.

This new type dump bailer has a full opening bottom, which is closed, sealed and retained by a shear stud and cup. The stud is electro-explosively controlled which permits the bottom to be released and the cement dumped at any point desired even on previously placed "green" cement. Several loads of cement can be made without waiting on the previous dump to set.

Coarse gravel or sand can also be run and dumped with this type bailer. This tool also allows the use of slow-setting cements for extreme depths and temperatures. However, quick setting materials can be dumped at shallow depths.

The electric wire line cement dump bailers are in sizes from 1-11/16-in. OD to 2-1/6-in. OD in lengths of 10 and 20 ft and can be attached together for lengths up to 100 ft. A 3⅝-in. OD bailer is used in casing operations.

The tubes and other parts are all aluminum using internal upset threaded joints to provide a smooth external flush outside diameter for easy passage through the tubing, yet maintain maximum capacity.

Running the Bailer

To assemble the bailer for operation, the release detonator is placed in the shear stud and conductor wire is threaded through the tubes as the bailer is lowered into the tubing. Special elevator type slips are used to hold the last joint at the well head so that additional joints can be added safely and quickly. Generally, 50 ft of bailer is run at one time making a 5-ft fillup in 5½-in. casing.

The upper head of the bailer filling window connects to the rope socket and collar locator assembly, which aids in exact depth control on every run. The bailer is lowered into the well and withdrawn at normal line speeds.

The bailer has been used successfully under low flowing pressures. This, however, is a much slower and a more expensive operation but is economically practicable for remote locations.

Cement for the Plug

Normally, a 10-ft column of slow-setting neat cement (5½-in. casing) is adequate for most plug-back jobs. However, longer columns can be used for greater pressures.

The cement is mixed to 16 lb per gal in a special mixing vat with an electric hydro mixer. Special scales are provided so that the mix is as exact as field conditions will permit. Cement is stored in polyethylene bags so that shelf life of the cement will not affect a good cement plug. For through-tubing dump bailer work, where small amounts are involved, the cement is carefully selected, stored, and handled.

Locating the Plug

When locating the cement plug, it is desirable to place the bridge plug and column of cement so that it is opposite a collar or in perforations. This, of course, gives added strength to the plug. It should be noted that cement, when dumped in perforations, does not always fill up to the calculated height due to cement loss in the cavity immediately behind the perforations. A plug-back opposite perforations could be slightly more expensive, due to more dump bailer runs, but it will certainly furnish an excellent plug-back. The cement can be "squeezed" into the perforations. Pressures at the surface can be placed on the cement with the bailer in the well, but a special electric wire line blowout preventer must be used. Extra runs can be made to make up the cement loss from the "squeeze."

Pressure tests on cement plug. Recent surface tests have indicated that a 10-ft column of neat slow-setting cement in smooth 5½-in. casing, after setting 48 hours at 80 to 90 F, will support, without leaks, a differential of 3000 to 3400 psi.

Many field tests have been completed on this type plug-back in 5½-in. casing using differential pressure tests of 4000 to 4400 psi on a 10-ft cement plug placed opposite a collar. At this writing, the through-tubing bailer and bridge plug have been used successfully in wells to 13,000 ft. In some special cases, this plug-back system has been completed successfully under low surface pressure; however, this is a new technique and must be thoroughly field tested.

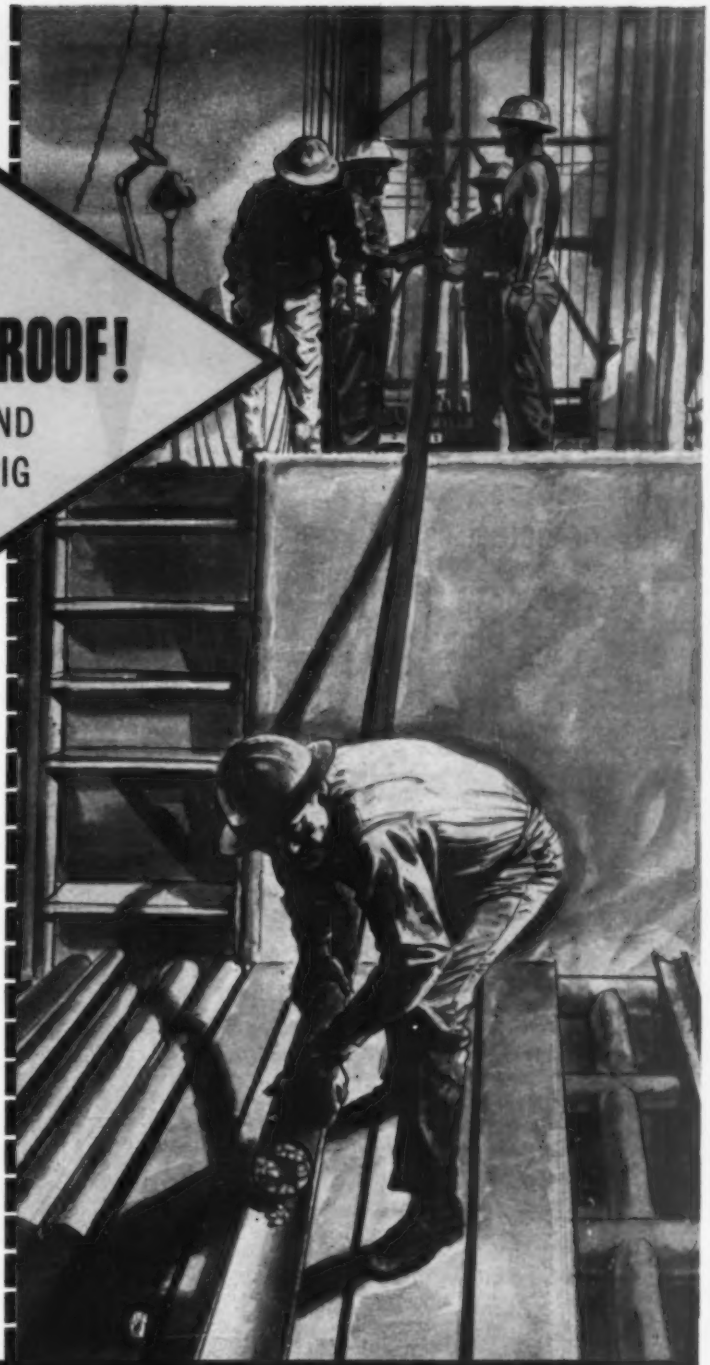
Cement mixing and other equipment are carried to the job in a trailer which also contains special wellhead tools, work platforms, lubricators, etc., that are essential to complete a job quickly and safely. A special mixing water supply tank is part of the trailer.

Steps in a Typical Through-Tubing Plug Back

In actual field operations, details of a typical through-tubing plug back job follow these steps:

HERE'S PACKAGED PROOF!

OF THE GROUND BELOW THE RIG



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BIT #1408, 6 9/16" O.D.

Averaged 5.7 ft./hr. from 9,700 to TD of 12,350 in Duval County, Texas. Then it was run in a second well in Kenedy County from 10,006 to 10,759 at an average of 3.4 ft./hr. This one bit racked up a total 3,403 feet of hole through sand and shale.

BIT #1457, 6 1/16" O.D.

Averaged 4.1 ft./hr. through 1,328 feet of Miocene in Acadia Parish, Louisiana. Drilling in the first 500 feet was limited by operator to 6 ft./hr. due to hole condition, but the bit could have made 15 ft./hr. And it was good for lots more hole after reaching TD of 14,100.

BIT #1469, 5 23/32" O.D.

Averaged 2.8 ft./hr. from 16,603 to 17,500 in Jeff Davis Parish, Louisiana. Replaced an estimated 25 rock bits for which the trip time alone would have cost about $17,500. Other drilling costs were reduced proportionately because of the time saved.

These are the records of three bits in wells recently completed. And they're typical. We've picked them to show the exceptional economy of drilling with our V-Door bits in the Gulf area.

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1. Special equipment (gin pole, power winch) is set up at the well. No rig is required. A through-tubing radiation log is run to provide accurate depth control during all phases of the operation.
2. A gage bar is run and a collar log is made to the depth where the plug is to be set.
3. The plug is made up and run to a pre-determined depth. The line is energized and the plug is set. The setting tool is then withdrawn.
4. The dump bailer is made up and hung in the tubing.
5. Cement is mixed and poured into the dump bailer, which is lowered to the plug and dumped.
6. Subsequent dump bailer runs are made to obtain the fillup required. (See Table 1.)
7. The well is "shut in" for 16 to 24 hours, depending on the depth and temperature.
8. The well then can be pressure checked to determine strength of the plug. This test allows the "go-ahead" on perforating above the plug.
9. To perforate an upper zone, a retrievable swing jet carrier is run to the zone and fired.

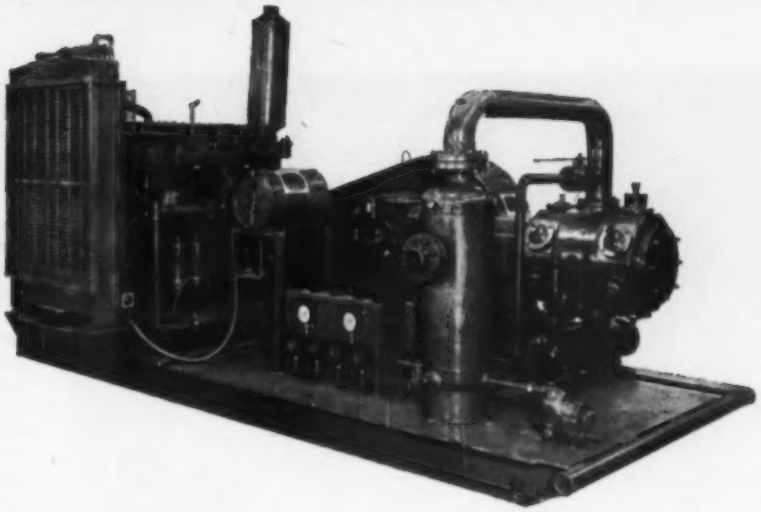
This completes a remedial plug-back and perforating job through tubing without a rig in an elapsed time of 24 to 30 hours.

Some Field Plug-Back Operations

A recent interesting field case history involved a water location in the Gulf Coast. The plug back operation through the tubing was to be accomplished with the well under pressure. Original wellhead pressure was 1300 psi. The well was pumped into and surface pressure was reduced to 600 psi. But, after running the dump bailer, pressure built back to 1300 psi, probably due to swabbing action. Bailer was run through a pressure lubricator, and only a 20-ft section of the bailer could be run at one time. Two runs were made with a 1-11/16-in. bailer under 500 to 600 psi. After dumping the cement, the well was shut in to allow 5 ft of slow setting cement to set.

After setting over night, the well pressure measured 175 psi. Another 5 ft of cement plug was added on top of the existing plug in two dump bailer runs. The well was again shut in for 24 hours. Agitation of gas prevented a good seal on the first dump. After setting, the plug sealed the casing and surface pressure was zero. To test the plug seal, tubing was pressured to 2200 psi for 30 minutes. No loss of pressure indicated the seal was satisfactory.

The well was then perforated with a 30-ft long retrievable swing jet carrier with four shots per foot. Estimated



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These features mean profit and satisfaction to you:

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- Sealed distance-piece.
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- Window-type oil level indicator.
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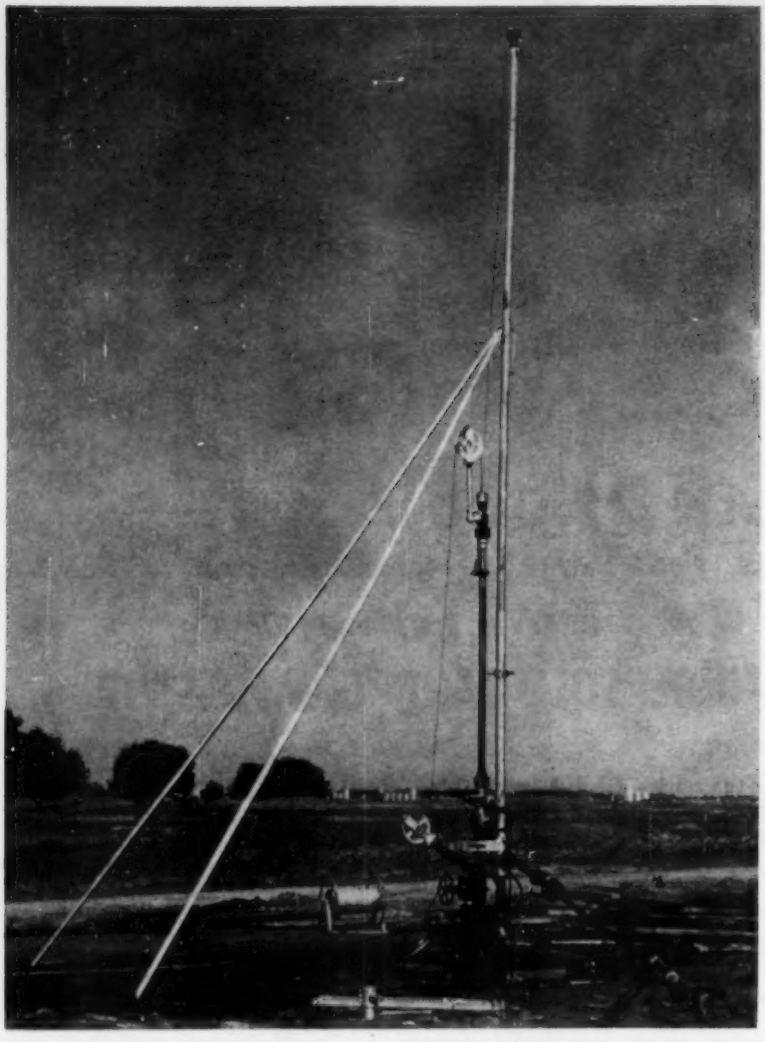

Well head set up for through-tubing bridge plus operation. Aluminum gin pole with supports lifts lubricator and wire line blowout assembly. Note that flow line connection and master valve are not disturbed.

savings on this water location amounted to $6000 over a conventional plug-back job.

Typical land location operation. This Gulf Coast well had 7-in. casing set to 10,200 ft. Two inch, EUE, N-80 tubing was set in a packer at 9310 ft with a tail pipe extending to 9314 ft. No surface pressure was expected during plug-back operations, although it was anticipated that 2000 psi pressure would exist after perforating in new zone from 9501 to 9536 ft. Old perforations were from 10,120 to 10,140 ft.

The well head was first tested to 4000 psi, and a 3/16-in. wire line truck was set up using dual blowout preventers and special pack-off. A gage bar was run to 10,120 ft, and a strip record collar log was made to locate casing collars, tail pipe and packer.

A 7-in. through-tubing casing bridge plug was set between 9600 and 9800 ft, 4 ft below a casing collar. This location was recorded on a collar log chart. Three runs were made with a 50-ft length of 1-11/16-in. OD bailer using 16 lb per gal slurry of slow setting cement to make a 9-ft cement plug.

The well was shut in for 24 hours and a pressure test to 2400 psi showed the plug to seal tight. The well was then perforated with the through tubing retrievable swing jet carrier in two 18-ft runs with 4 shots per ft. The well was allowed to clean itself before connecting into the flow line.

An analysis of this plug-back operation indicated a saving of $4000 over conventional methods . . . plus the added days of production due to the short time required in the through-tubing plug-back operation.

Reference

1. T. A. Huber and Gilbert Tausch, "A Simplified Cementing Technique For Recompletion Operations," AIME paper TP 3739, Vol. 201, 1954.

★ ★ ★

TABLE 1. Cement Dump Bailer Fillup Data.

Slurry wt lb/gal	Gal water per sack	Lb water per sack	Slurry vol per sack in gal	Slurry vol per sack in lb	Slurry vol per sack in cu ft	1 11/16" bailer mix per 10' sec		2 1/16" bailer mix per 10' sec		3 5/8" bailer mix per 10' sec	
						Water lb	cement lb	water lb	cement lb	water lb	cement lb
16.2	4.5	37.3	8.1	131.22	1.08	4.6	11.6	6.5	16.6	20.7	52.2

PIPE SIZE & WEIGHT			LINEAL FEET OF PIPE FILLED PER 10' SEC. OF DUMP BAILER			LINEAL FEET OF PIPE FILLED PER	
O.D.	WT-LB	I.D.	1 11/16"	2 1/16"	3 5/8"	Gallon	Sack of Cement
2 3/8	—	2.000	6	—	—	6.0	49
2 7/8	—	2.441	4	5.9	—	4.0	33
*2 7/8	10	2.151	5	7.6	—	5.0	42
*3 1/2	13	2.764	3	4.6	—	3.2	26
*3 1/2	15 1/2	2.602	3.6	5.2	—	3.0	39
*4	14	3.340	2.2	3.1	—	2.0	17
*4 1/2	16 1/2	3.826	1.6	2.4	—	1.6	13
4 1/2	11 1/2	4.000	1.5	2.2	—	1.5	12
5	18	4.276	1.3	1.9	5.5	1.3	10
5 1/2	17	4.892	1.0	1.5	4.6	1.0	8
6 5/8	24	5.921	.7	1.0	3.1	.7	5
7	26	6.276	.6	.9	2.8	.6	5
7 5/8	29	6.875	.5	.7	2.3	.5	4
8 5/8	36	7.825	.4	.6	1.8	.4	3
9 5/8	43	8.755	.3	.4	1.4	.3	2

REF:

(A) A sack of cement contains 1 cu ft or 94 lb or approx. 7.5 gal or 12.5 lb per gal.

(B) 1 cu ft equals 7.48 gal, 1728 cu in. 1 gal water weighs 8.3 lb or 231 cu in. or .1337 cu ft.

NOTE:

1. This chart is approximate and should not be compared with pumpable slurries.
2. Calculations are based on 16 lb/gal slow setting cement.
3. Thickening time approx. 6 hr @ 8000', 3 hr @ 11,000' using slow setting cement.
4. 10' of 1 11/16" bailer contains 1.0 gal. 10' of 2 1/16" bailer contains 1.4 gal. 10' of 3 5/8" bailer contains 4.5 gal.

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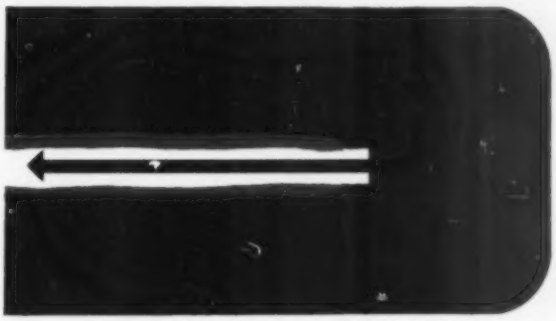

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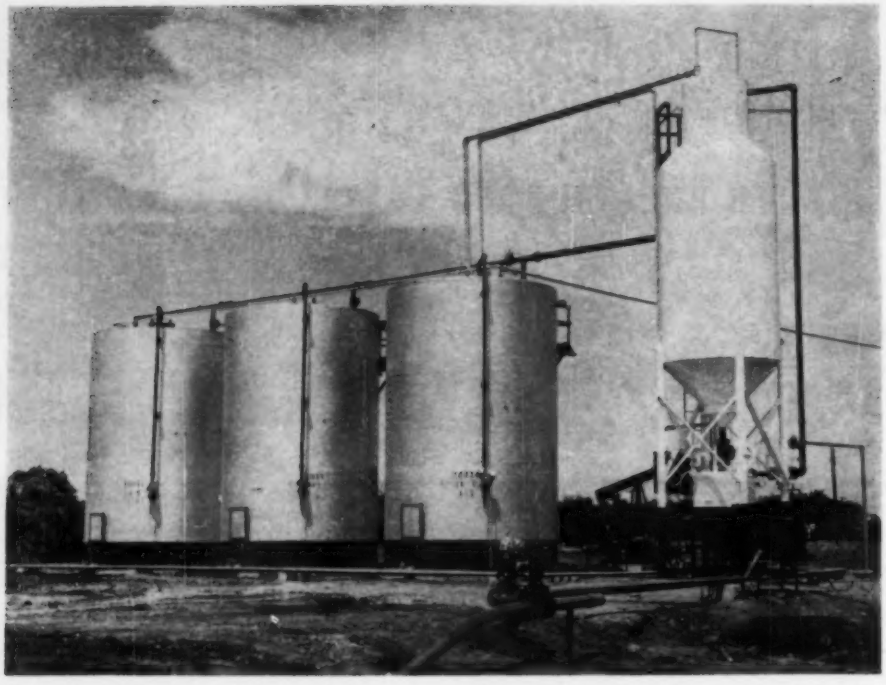


FIG. 1. **One of five** lease automatic custody transfer batteries operated by Shell Oil Company in the Big Mineral Creek field in Grayson County, Texas. Oil flows into three 210-bbl surge tanks and is then automatically measured in 60-bbl weir-type run tank (right) and dumped to pipeline.

LACT system in North Texas is framework of . . .

ONE OF SHELL'S LARGEST AUTOMATED FIELDS

Five automatic batteries handle approximately 3000 bbl oil per day from 12 leases in the Big Mineral Creek field of Grayson County, Texas

Lowell A. Murphy,
Field Editor

AUTOMATION IN THE PRODUCTION OF OIL is increasing rapidly. One of the most complete LACT (lease automatic custody transfer) systems in Texas is being operated by Shell Oil Company in Grayson County, only a stone's throw from the banks of Lake Texoma. Operation of the system, which consists of five automatic batteries, began on January 27, 1958. The non-operators, which are associated with Shell as co-owners of some of these facilities, are: Walter Beardsley, D. Douglas Oil Company, M. Douglas Oil Company, George W. Humphreys, Lloyd Oil Company, Pitts Oil Company, Snuggs and Neal, Inc., Fred Snuggs, R. H. Snuggs, K. R. Neal, and Frank C. Weimer. As of September 30, 1958, approximately 450,000 bbl of oil had been run through the batteries to the pipeline owned by Sinclair Pipeline Company.

The system handles oil produced from Shell's 12 leases in the Big Mineral Creek field, which is the largest field operated by Shell in North Texas. At the time Shell began studying the field for possible installation of automatic custody transfer equipment, there was a total of 91 producing wells on the company's leases. Of these, 40 were producing by natural flow, 15 by conventional pump, and 36 were equipped with hydraulic pumping equipment. As more and more of the wells were put on artificial lift, lease operation costs continued to climb, giving impetus to Shell's study of automatic operation of the field. Also, much of the lease equipment was destined for

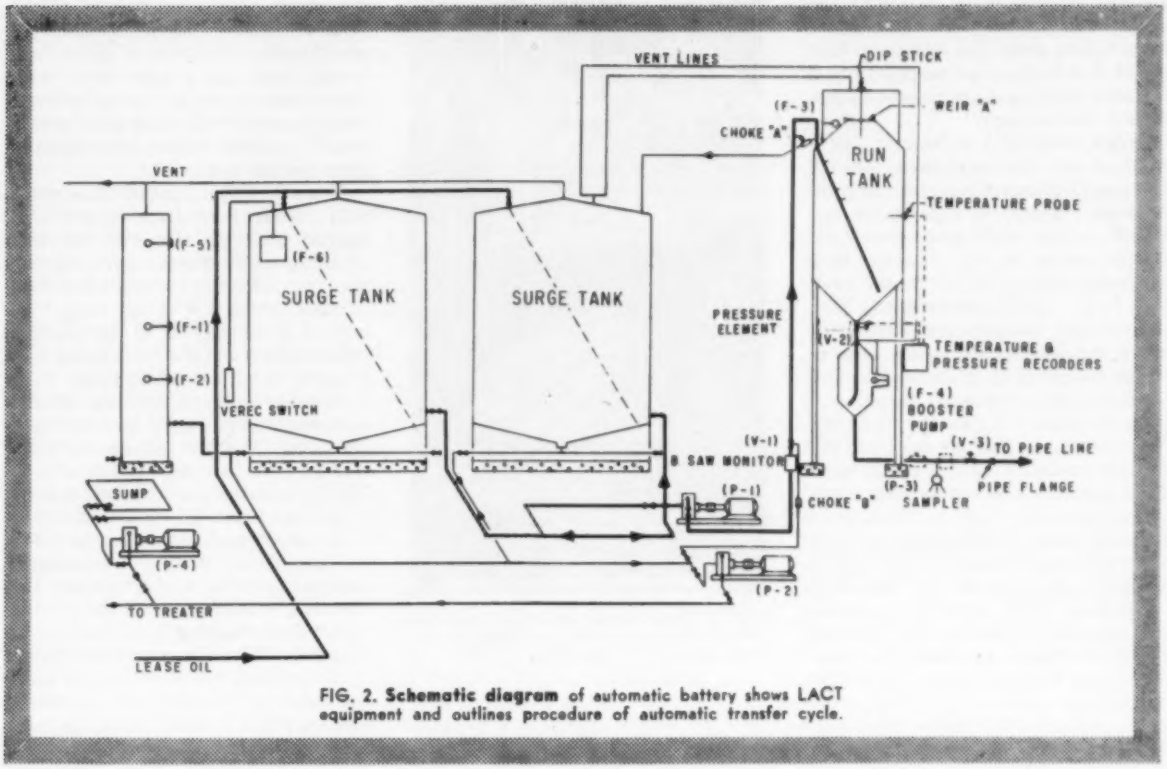


FIG. 2. **Schematic diagram** of automatic battery shows LACT equipment and outlines procedure of automatic transfer cycle.

replacement to extend production facilities for the estimated 36-year primary life of the field.

Economic Justification

Preliminary economic studies of the proposed project to install LACT equipment in the Big Mineral Creek field began with a study of existing lease facilities. The 12 leases of the field were being produced into 7 tank batteries which had a total of 49 lease tanks, ranging in size from 210 bbl to 500 bbl. Installation of LACT systems would permit more than half of these tanks to be salvaged, with the remainder to be used in the new LACT systems. In addition, other equipment could be salvaged, such as valves, pipe, and fittings.

Installation of LACT equipment in the Big Mineral Creek field would also result in additional revenue realized from the reclamation of oil that was formerly lost in the form of escaped vapors and paraffin-rich tank bottoms. Since the automatic batteries would constitute essentially a closed system, vapor recovery in such a system would be high and would result in an increase in the gravity of the oil delivered to the pipeline. The value of reclaimed oil resulting from recovery of vapors and tank bottoms was calculated to be approximately $14,000 per year.

Automatic custody transfer would also eliminate the need for a pumper to operate the leases, resulting in another savings of $600 per month.

In calculating the investment which would be required for conversion to LACT operation of the field, engineers arrived at a figure of $78,000. This amount would cover the costs of the entire conversion, including designing, planning, equipping, piping, transporting, installing, painting, and supervising the entire project from the start to the point of actual operation. The value of equipment presently salvable was calculated to be $13,000, leaving a net investment required of $65,000. On the basis of savings to be realized from the reduction of labor costs and the value of reclaimed oil, the payout of the net investment was calculated at approximately 2.7 years.

Design and Operation

Each of the automatic batteries is provided with weir-tank measuring systems and is designed to perform the following functions.

1. Run clean oil to the pipeline automatically.

2. Measure the volume of oil run by counting the number of times that the weir tank dumps a measured batch of oil.

3. Record the temperature of the oil at the time it is dumped.

4. Catch a sample of oil for manual determination of oil API gravity and BS&W content.

5. Cease operating when the lease allowable has been run.

6. Shut in all producing wells on prolonged failure to run oil.

Fig. 2 is a schematic diagram of one of the automatic batteries. The complete cycle of operation of the battery begins when lease production enters the surge tanks at the battery, filling all tanks at the same time, equalizing the tanks and providing effectively one large surge volume for produced oil. The pipeline connections and drain outlets of all tanks are tied together and connected with the pump which fills the run tank.

Since the surge tanks are equalized, oil levels are always equal in all tanks. Oil level also rises equally in a small float chamber tied into the tanks. This float chamber contains the limit switches and was provided to eliminate the necessity of mounting the float switches in the surge tanks. When the oil level rises in the float chamber to the height of float switch F-2, the switch is closed and activates the small pump P-2. This pump circulates oil continuously from the bottom of the tanks back to the lease treater to keep the paraffin in solution and to knock out additional BS&W.

As the oil level continues to rise in the surge tanks, float switch F-1 is

closed and starts pump P-1 to fill the run tank from the surge tanks. However, before pump P-1 will start, float switch F-4 in the small surge pot must be in the down position, indicating that the run tank is empty.

When pump P-1 is started, oil is pumped from the surge tanks into the run tank. Before entering the run tank, oil passes through the capacitance-type BS&W monitor which determines if the BS&W content of the oil is less than the maximum acceptable by the pipeline. If the BS&W content is too high, the monitor switches the position of valve V-1, a three-way valve, and bypasses this oil back to the surge tanks.

If the oil is clean, it is pumped through valve V-1 into the run tank. Valves V-2 and V-3 are closed at this time to assure that oil is not drained from the tank while it is being filled. As oil enters the run tank, the level of the tank builds up, eventually reaching weir "A", which is simply an opening in the top cone of the tank.

Oil then spills over the weir into the top chamber of the run tank causing the level to build up around the cone. This rising fluid raises float switch F-3, which after a short time delay, shuts down pump P-1 and closes valve V-1. This delay permits the fluid level to build up several inches above the top of weir "A" before pump P-1 is stopped.

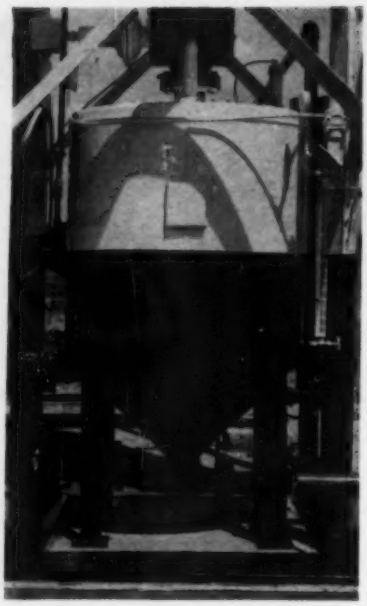


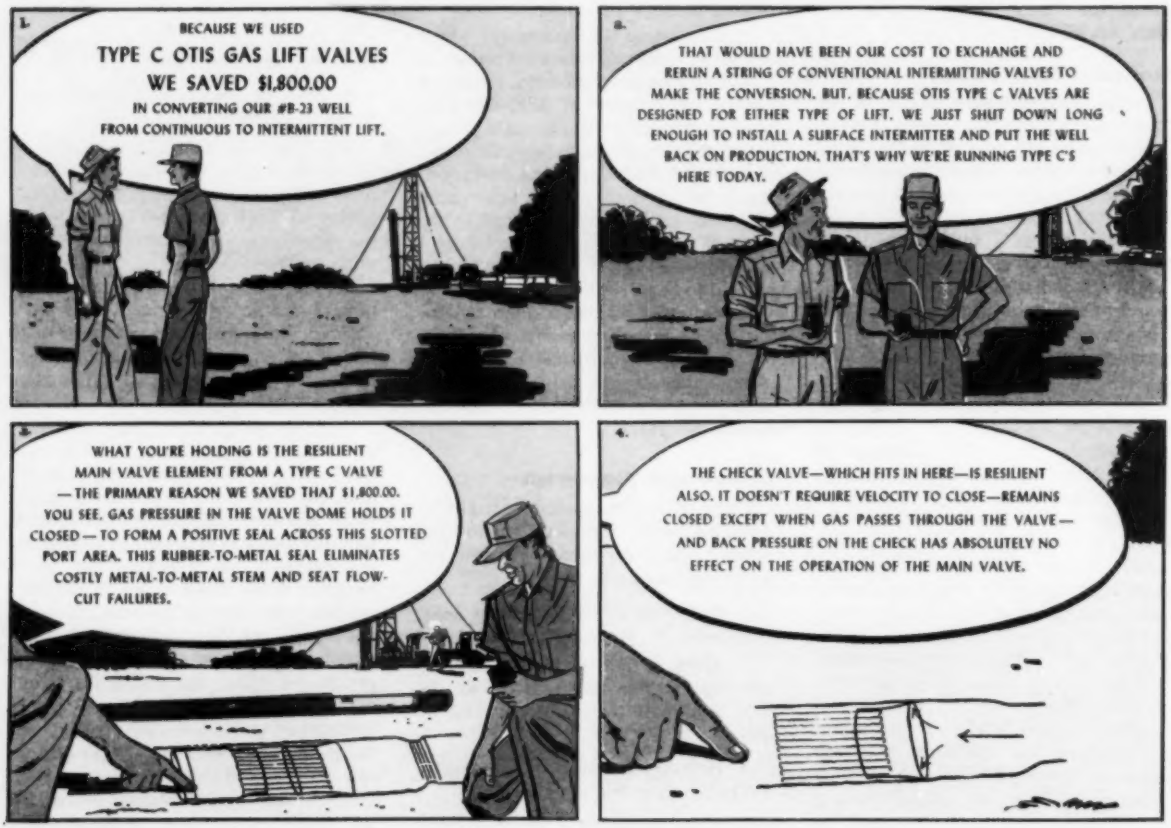
FIG. 3. **Small surge pot** below run tank contains float switch which marks bottom level of oil volume run to pipeline.

As the top chamber of the run tank is higher than the surge tanks, oil in the top chamber drains back to the surge tanks through a line containing a small orifice. This orifice, choke "A", is sized such that it takes from 15 to 25 minutes for the oil level to fall back to float switch F-3, which gives the oil time to weather before being dumped from the run tank.

When the oil level falls to float switch F-3, causing it to drop, valve V-2 is opened. Oil then falls into the float chamber under the run tank, causing float switch F-4 to be raised. The raising of float switch F-4 opens valve V-3, and oil is transferred to the pipeline either by gravity flow or by pump P-3, provided valve V-2 is fully open.

As oil is run to the pipeline, the run tank empties and the oil level falls past valve V-2. The float chamber beneath the run tank also empties until the oil level reaches float switch F-4, causing it to drop. When this float switch falls to its down position, valves V-2 and V-3 are closed, valve V-1 is opened, and pump P-1 is started to refill the run tank, provided the oil level in the 12-in. float chamber is at least up to float F-1. Thus, a new cycle is begun.

In the event that oil is not run from the automatic battery for a considerable period, either due to the production of bad oil or the inability of the pipeline to take the oil, the fluid level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FROM CONTINUOUS TO INTERMITTENT LIFT.
2.
THAT WOULD HAVE BEEN OUR COST TO EXCHANGE AND RERUN A STRING OF CONVENTIONAL INTERMITTING VALVES TO MAKE THE CONVERSION. BUT, BECAUSE OTIS TYPE C VALVES ARE DESIGNED FOR EITHER TYPE OF LIFT, WE JUST SHUT DOWN LONG ENOUGH TO INSTALL A SURFACE INTERMITTER AND PUT THE WELL BACK ON PRODUCTION. THAT'S WHY WE'RE RUNNING TYPE C'S HERE TODAY.
3.
WHAT YOU'RE HOLDING IS THE RESILIENT MAIN VALVE ELEMENT FROM A TYPE C VALVE —THE PRIMARY REASON WE SAVED THAT $1,800.00. YOU SEE, GAS PRESSURE IN THE VALVE DOME HOLDS IT CLOSED—TO FORM A POSITIVE SEAL ACROSS THIS SLOTTED PORT AREA. THIS RUBBER-TO-METAL SEAL ELIMINATES COSTLY METAL-TO-METAL STEM AND SEAT FLOW-CUT FAILURES.
4.
THE CHECK VALVE—WHICH FITS IN HERE—IS RESILIENT ALSO. IT DOESN'T REQUIRE VELOCITY TO CLOSE—REMAINS CLOSED EXCEPT WHEN GAS PASSES THROUGH THE VALVE—AND BACK PRESSURE ON THE CHECK HAS ABSOLUTELY NO EFFECT ON THE OPERATION OF THE MAIN VALVE.

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builds up in the surge tanks, eventually lifting float switch F-5 or F-6. The raising of either of these float switches shuts in all producing wells. After float switch F-5 or F-6 has tripped, the lease producing wells remain shut in until sufficient oil has been run from the battery to drop the oil level in the surge tanks to float switch F-1. The wells then come on automatically. It is however, necessary to restart the gas engines driving the triplex pumps of the hydraulic pumping systems.

Run-Ticket Information

Volume of oil run is determined by counting the number of times the run tank, which has a fixed volume, is dumped. Each time valve V-3 opens, indicating a tank is being dumped, three counters—two at the control panel and one in a central field doghouse—are pulsed. One of the counters at the battery control panel is preset to the number of dumps equal to the month's allowable production. When the allowable is made, this counter automatically ceases all further pipeline deliveries and shuts in all wells when the surge tanks are filled. The number of dumps are also counted on the temperature recorder and pressure recorder charts, and can be checked from these indications.

Temperature of the oil as run is recorded on a circular chart in a panel mounted on the run tank. A sample of the oil is taken while the run tank is dumping. The BS&W content of the oil run is determined by a manual grind-out of this oil. Oil API gravity is found by immersing an hydrometer in the oil sample.

Control and Indicating Equipment

The control panel installed at each of the automatic batteries is a schematic diagram of the battery equipped with indicating lights which show at any time the status of all float switches, valves, and pumps. This panel is color-coded to correspond to the painted color of the tanks, valves, piping, and other components of the battery. This arrangement permits immediate evaluation of the custody transfer procedure and shows instantly the source of any malfunction of the system.

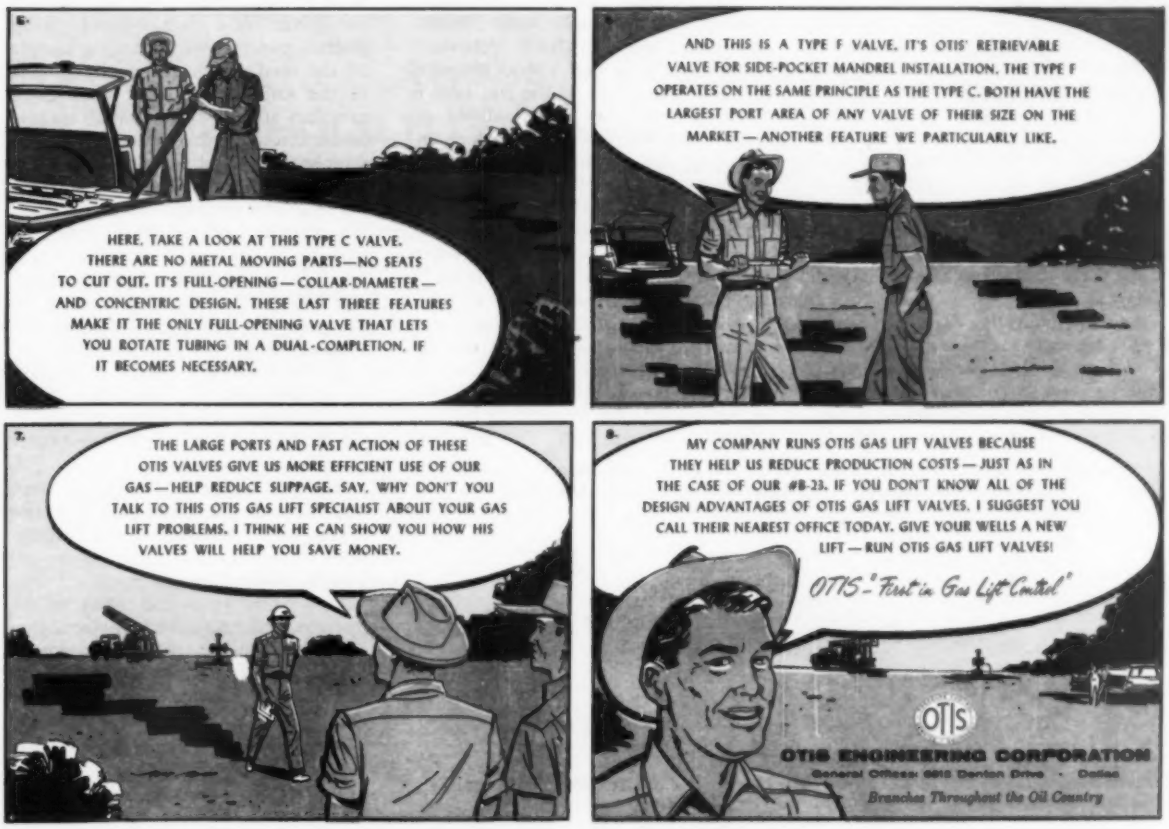
In conjunction with the control panel at the battery, there is also a centralized panel at one of the batteries which shows the operation being carried out at all of the batteries. This panel consists of lights which indicate when the surge tanks are receiving oil, when they are filled, when oil is being delivered to the pipeline, or when bad oil is being diverted back to the lease treaters. This remote station also includes counters which show the total number of dumps made by the run tanks of the various batteries into the pipeline.

Production from the five automatic batteries is delivered to the pipeline of Sinclair Pipeline Company. Three of the batteries deliver oil to the pipeline by gravity flow, while transfer is made at the other two batteries by pump, owned by Sinclair at one battery and by Shell at the other.

Prior to installation of LACT equipment in the Big Mineral Creek field, Shell had operated an automatic custody transfer system in the Antelope field of Clay County, Texas. This system had been on trial for a year. The design of the Big Mineral Creek installation was based on this system and incorporated similar operating principles. In view of the completely satisfactory operation of the Antelope field installation, the Texas Railroad Commission granted permission for operation of the Big Mineral Creek system based on design alone, requiring no trial.

New LACT Features

Several features of the Big Mineral Creek installation are worthy of special


HERE, TAKE A LOOK AT THIS TYPE C VALVE. THERE ARE NO METAL MOVING PARTS—NO SEATS TO CUT OUT. IT'S FULL-OPENING—COLLAR-DIAMETER—AND CONCENTRIC DESIGN. THESE LAST THREE FEATURES MAKE IT THE ONLY FULL-OPENING VALVE THAT LETS YOU ROTATE TUBING IN A DUAL-COMPLETION, IF IT BECOMES NECESSARY.
AND THIS IS A TYPE F VALVE. IT'S OTIS' RETRIEVABLE VALVE FOR SIDE-POCKET MANDREL INSTALLATION. THE TYPE F OPERATES ON THE SAME PRINCIPLE AS THE TYPE C. BOTH HAVE THE LARGEST PORT AREA OF ANY VALVE OF THEIR SIZE ON THE MARKET—ANOTHER FEATURE WE PARTICULARLY LIKE.
THE LARGE PORTS AND FAST ACTION OF THESE OTIS VALVES GIVE US MORE EFFICIENT USE OF OUR GAS—HELP REDUCE SLIPPAGE. SAY, WHY DON'T YOU TALK TO THIS OTIS GAS LIFT SPECIALIST ABOUT YOUR GAS LIFT PROBLEMS. I THINK HE CAN SHOW YOU HOW HIS VALVES WILL HELP YOU SAVE MONEY.
MY COMPANY RUNS OTIS GAS LIFT VALVES BECAUSE THEY HELP US REDUCE PRODUCTION COSTS—JUST AS IN THE CASE OF OUR #B-23. IF YOU DON'T KNOW ALL OF THE DESIGN ADVANTAGES OF OTIS GAS LIFT VALVES, I SUGGEST YOU CALL THEIR NEAREST OFFICE TODAY. GIVE YOUR WELLS A NEW LIFT—RUN OTIS GAS LIFT VALVES!
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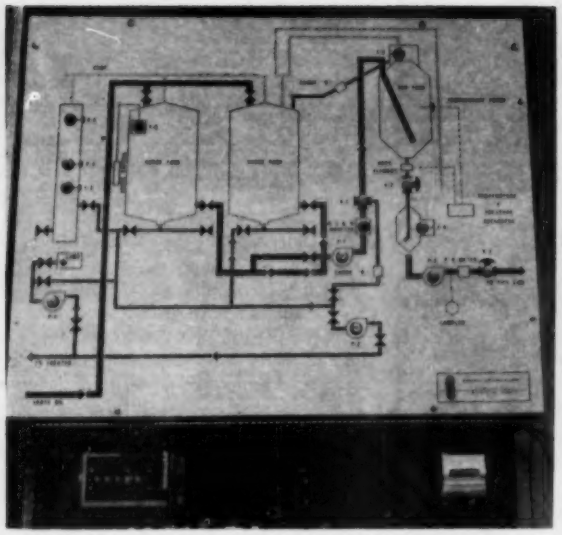

FIG. 4. **Control panel** at LACT battery is color-coded to correspond to painted colors of battery components. Lights indicate status of switches, valves, and pumps. Two counters provide record of oil run through the battery; one counter automatically limits production to lease allowable.

FIG. 5. **Centrifugal pumps** handle oil in the automatic battery. Pump in foreground transfers oil automatically from surge tanks to run tank. Small pump at right provides continuous circulation of oil in the surge tanks.

consideration. One of the most significant features is the continuous circulation of tank bottoms. This practice, of course, could not be applied in any and all automatic batteries, since in many circumstances the total BS&W content of the crude oil would not be within acceptable limits. However, since the tank bottoms in Shell's Big Mineral Creek production consist primarily of paraffin, the BS&W content of the crude is usually acceptable and the constant circulation results in added revenue in the form of reclaimed oil.

In addition to the results achieved from the continuous circulation, the problem of paraffin accumulation has been minimized by coating the inside of all surge tanks and run tanks with a special paint.

Another interesting feature of Shell's LACT batteries is the small float chamber which is tied into and equalized with the main surge tanks and in which are mounted the high-level and low-level float switches which control delivery of oil to the run tank. Mounting the float switches in this separate chamber eliminates their installation in the surge tanks and, incidentally, provides flexibility in the number of tanks operated in the custody transfer cycle.

The elevated run tank provides a positive-volume, single-dump measuring system using a valve to determine the bottom level and a weir to determine the top level. As the run tank is filled, a time-delay switch allows oil to flow over the weir into a small chamber above the run tank. This amount of oil then runs slowly back into the surge tanks, allowing a further delay of from 15 to 25 minutes before the run tank is dumped to the pipeline. This system provides ample time for weathering of the crude oil in the run tank.

A pressure recorder measures the pressure at the bottom of the run tank. Since the run tank is vented to the surge tanks, the pressure measured at this point is due to the fluid head of the oil in the run tank. This measurement provides a record of the filling and dumping of the run tank.

Samplers employed at the batteries automatically take samples of the oil run to the pipeline in proportion to the amounts run. The samples are collected in an air-tight pot. Two of the samplers are driven by explosion-proof, ¼-hp electric motors which pump a sample of the crude from the discharge line to the sample pot. The other three samplers are run from a small turbine in the discharge line which pumps the sample from the line in proportion to the amount of crude flowing through the line. The samplers have a five-gallon capacity and provide a composite sample of all crude run during a month's period from which the average API gravity of all crude run is determined. Payments are made on the basis of this gravity determination.

Before installing LACT equipment in the Big Mineral Creek field, Shell had improved the treating system in the field by adding at least one treater at each tank battery.

The volume of oil which has been run through the automatic batteries attests to the success of the installations. However, Shell engineers are not merely sitting back to watch oil flow automatically from the leases to the pipeline, but are constantly studying and evaluating the many procedures and pieces of equipment operating in the installations. And in the Big Mineral Creek field installations, Shell Oil Company has one of the finest laboratories for the development and perfection of lease automatic custody transfer systems. ★ ★ ★

Operational Information — Big Mineral Creek Lease Automatic Custody Transfer Batteries.

Lease No.	Storage volumes bbl: Between floats F-5 & F-1	Above float F-5	Run tank volume bbl	Pumping rates bbl per day: Pump P-2	Pump P-4	Cycle time—min.: Fill	Weather	Dump	Total	Max. cap. of battery* bbl/day
1.	2390	170	200.13	171	1500	23	30	40	93	3100
2.	550	115	90.36	171	570	20	18	64	102	1270
3.	475	80	60.03	171	1500	13	25	57	95	910
4.	475	80	60.02	171	950	13	22	60	95	910
5.	235	40	60.05	171	1500	13	20	54	87	990

*These capacities are true for present pipeline pumps and are based on an 8-day production month with all automatic batteries operating.

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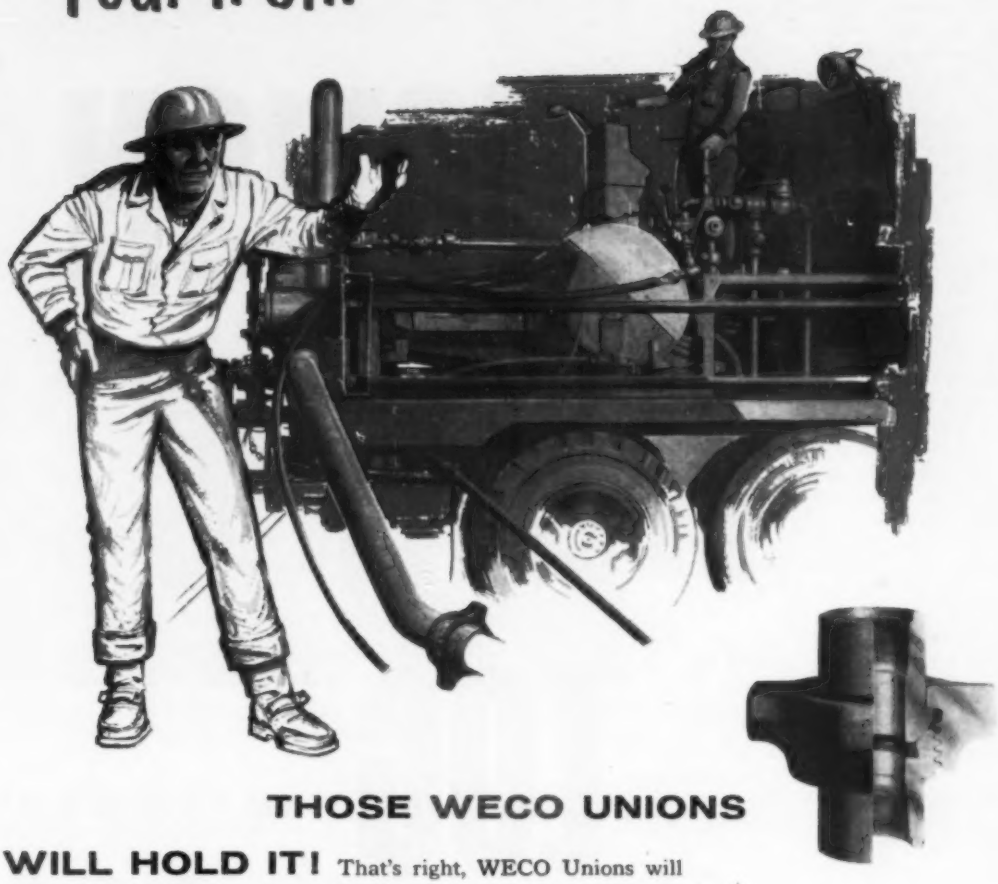

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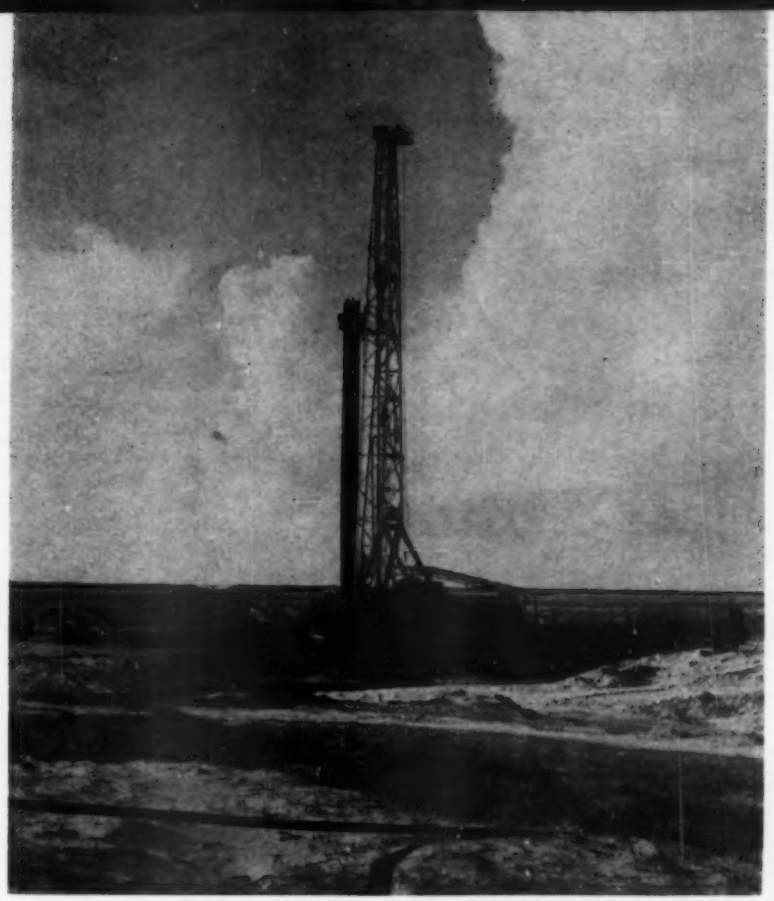


Deepest bit into Australian soil today is being directed by WAPET (Western Australian Petroleum) to a depth of 12,500 ft. The rig is now located in the Canning Basin, 40 miles from Derby.

AUSTRALIA:

Oil Activity Without Oil

WAPET, Santos, Delhi, Australian O&G, Woodside, Clarence River Oil companies explore — and drill — in every region, with little to show for the effort

DESPITE the fact that oil has not yet been found in Australia in commercial quantities, the search is being continued. The area of greatest activity is in West Australia where West Australian Petroleum Company (WAPET) is making concentrated efforts by every known method of field activity—including drilling.

Western Australia

The prospecting area held by WAPET is divided into three zones: (1) The Perth Basin of 20,000 square miles stretching from Perth to Geraldton; (2) the Carnarvon Basin of 63,000 square miles stretching from Geraldton to Port Hedland and; (3) the Canning and Fitzroy basins, 140,000 square miles which stretch from Port Hedland to Derby and inland to the Northern Territory. This is generally known as the Desert Basin.

The exploration methods being used include geological field work, structure drilling, test drilling, airborne magnetometer, gravity meter, and seismograph.

Up to September 1957 WAPET spent $29,059,000. In view of the unexplored nature of much of the country, 6585 miles of access roads were built at a cost of about $150,000. In all, 56 wells have been put down of which 25 were exploratory and 31 structure. The total cost for this work has been $7,940,000. The average cost per foot in exploratory wells has been $68.11, and for structure wells, $23.53. The most expensive well was Cape Range No. 2, $80.91 per ft; and the cheapest, Dirk Hartog No. 4 at $7.50 per ft.

The company has been using seven different types of drilling equipment, including: Two 1000 ft capacity drilling trucks, two 3000 ft rigs, one 5000 ft rig, one 10,000 ft rig and a 15,000 ft depth capacity rig.

It is interesting to note that three seismic crews (Geophysical Services, Inc.) have been operating and they have found that the West Australian areas involved are some of the most difficult in the world. One of the chief problems is the lack of water needed for drilling shot holes. In some areas air drilling has overcome the problem but even this method becomes useless when surface covers are loose sand or hard limestone. In this type of terrain it has been necessary to adopt the pattern-shooting-technique under which 36 shot holes are drilled and fired simultaneously, involving the use of 18 seismometers instead of the usual four.

At the present time drilling operations have been slowed so that the technical staff may reassess geological information from dry holes, with the object of selecting more promising drilling sites.

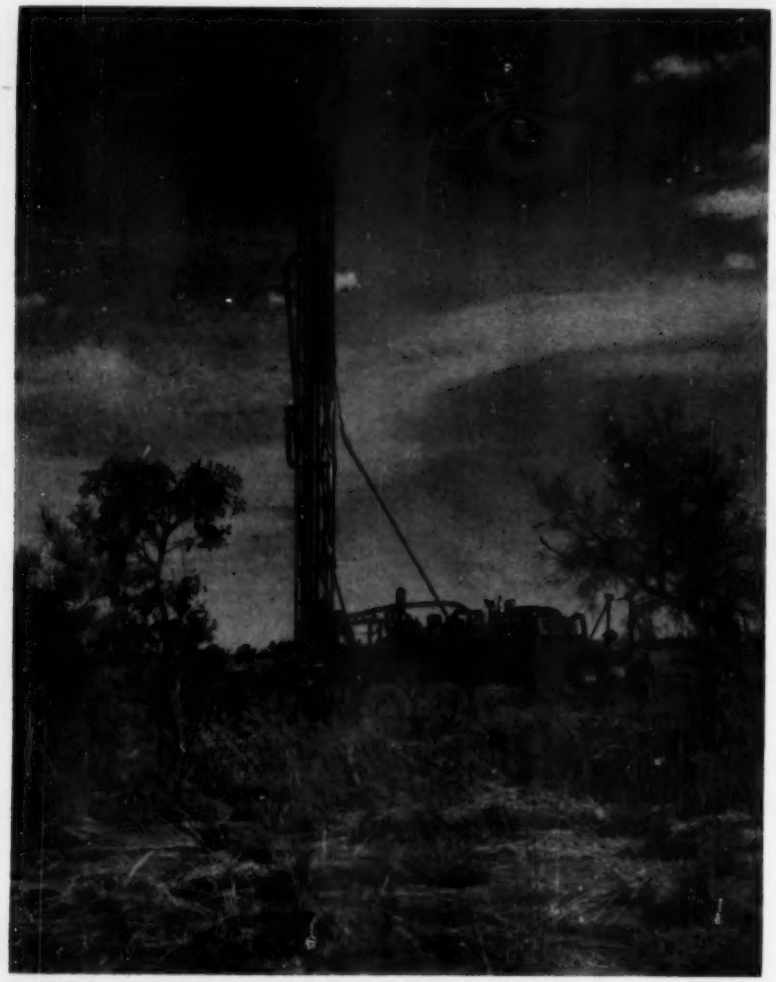
One new site has been selected at Meda (40 miles from Derby), in the Canning Basin and a 10,000 ft depth capacity rig has been moved 300 miles from Sapphire Marsh to the new site. Meda is in flat river plain country and in the wet season can be 12 ft under water. Hence, the hole must be drilled during the dry season. The hole had been drilled to 5,163 ft by August of this year.

In spite of several years of hard work, with only one showing of oil, in the first hole sunk, WAPET has plans for several years ahead and is determined, if commercial oil is to be found in the area, it will be found.

South Australia

Santos Oil Company has been busy for several years drilling in the Port Augusta Basin in South Australia using three light rotaries and two cable tool rigs. In the earlier period of its operations three cable tool rigs and three diamond drill shot hole rigs were in use but later these were replaced by two rotaries capable of drilling 4⅜-in. and 5⅜-in. holes to permit slimhole testing equipment to be used. A truck-mounted rotary is used mainly to penetrate the heavy artesian water-bearing Tertiary sands in the Cambrian limestone below 500 ft depths.

Exploration concession areas are scattered in all portions of Australia. The largest includes WAPET's three areas in the West, Delhi and Santos in the South, and Australian Oil & Gas areas in the East and Southeast.



WAPET exploration activity has been extensive and includes drilling, surface work, aerial magnetic surveys, seismic surveys, subsurface mapping and gravity work. This core drilling truck is attached to a seismograph party in the Canning Basin.

In this field high gravity oil occurs in the overlying Tertiary artesian water sands almost entirely over the several square miles so far drilled, but in small amounts only. Thick, heavy greases and paraffin waxes occur at the Cambrian limestone-Tertiary interface which is a line of major unconformity.

Small amounts of medium viscosity oil have been located in fracture porosity at depths of about 1000 ft, within the limestone, while the previously mentioned Tertiary oils appear to be escaping largely from high porous dolomitized reef-like Archaeocyathinae accumulations, which are lenticular in cross section.

This company has now entered into an agreement with Delhi Australia Petroleum, Ltd. (a subsidiary of Delhi Taylor Corporation) for a checkerboard exploration of the area held under prospecting license by Santos. The area will be divided into a number of squares of about 940 acres each and the companies will explore alternate blocks. The Delhi organization is to spend $3,000,000 to drill a stratigraphic well to a depth of at least 14,000 ft in the deeper part of the artesian basin. It retains the right to withdraw from the agreement if the results from the hole prove that the geology is hopeless.

Should Delhi find oil, then the South Australian Government gets 10 percent of the output and Santos 5 percent. Santos is to be provided with all information obtained by Delhi during drilling and other field operations and retains the full right to develop its own squares and retain the output.

This agreement is undoubtedly the biggest development in the search for oil in this country.

Sydney Basin

Australian Oil and Gas Corporation is active in drilling operations in the Sydney Basin searching mainly for gas in commercial quantities and up to the time of writing seven holes have been, or are being drilled. The finds of gas have been encouraging.

In five of the wells already drilled gas-flows of as much as 90,000 cu ft a day have been tested. The drilling of six additional holes has been recommended in the area to a depth of 2000 or 2500 ft. The company is now making financial arrangements for drilling these holes.

This company was also drilling one hole in the Mulgoa structure, now at a depth of 4500 ft. At Dural No. 2 bore was at 6294 ft in shale.

Several other companies are operating in Australia, including Woodside Oil in Victoria, and Clarence River Oil on the North Coast of New South Wales in the vicinity of Grafton. ★ ★

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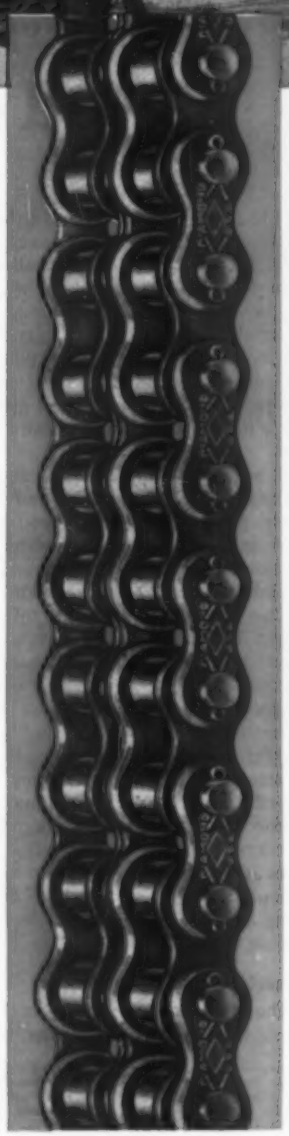

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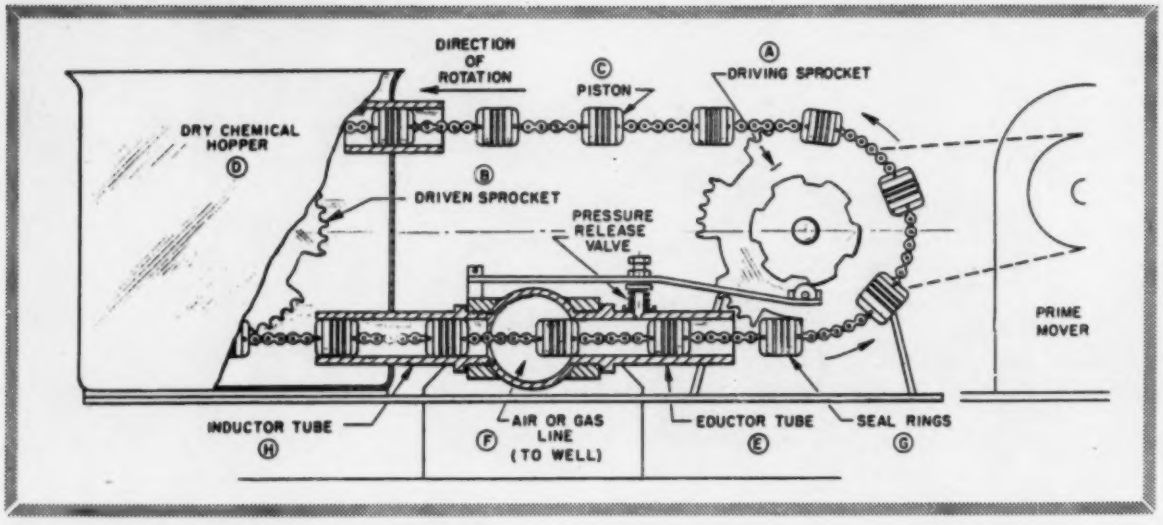

FIG. 1. **The solids injector** consists of a prime mover driving a pair of sprockets, forming a conveyor-chain assembly.

Solids Injector for Air and Gas Drilling

Pump permits controlled, continuous injection of stearates and powders into air stream against pressures up to 750 psi

B. V. Randall, J. L. Lummas and R. P. Vincent
Pan American Petroleum Corporation, Tulsa, Oklahoma

WITH the introduction of antiballing materials (stearates of zinc or calcium) to facilitate the handling of small quantities of water while drilling with air or gas, the problem of injecting solid material into a high-pressure gas supply line became apparent. To accomplish this objective, a pump was developed to inject granular or powdered material into a high-velocity high-pressure input line.

It has been found that the addition of the stearates of zinc or calcium effectively prevents agglomeration of bit cuttings in the presence of water production ranging from trace amounts to approximately 2 bbl per hour.

This procedure requires a solids injector. The device that has been developed for this purpose is satisfactory for injecting stearates or other finely ground powders into an air or gas stream against pressures as high as 750 psi. Prior to the development, the use of stearates to prevent "balling" was not effectively applied. Continuous injection of a controlled quantity of fine powders into the stream against pressures as high as 750 psi were extremely difficult. This solids injector is now being used on a routine basis by an air drilling company.

Description of Apparatus

The solids injector shown in Fig. 1 consists basically of a prime mover

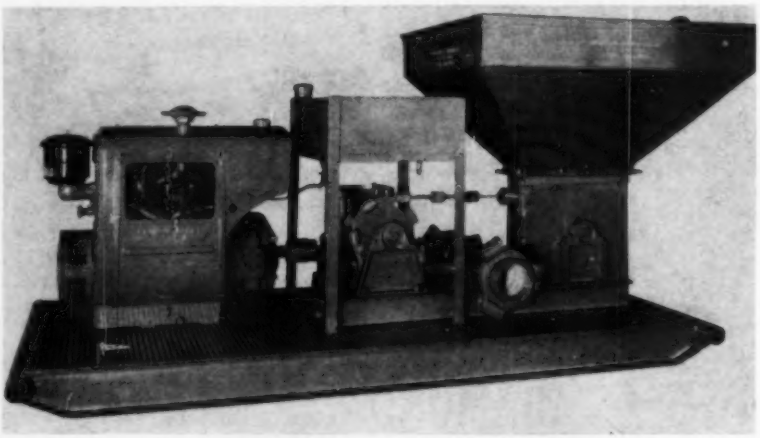

FIG. 2. **"Pump"** has been skid mounted, and in this case is driven by a gasoline engine. It is usually located between the air or gas source and the rig standpipe.

Adapted from "Combatting Wet Formations While Drilling With Air or Gas" presented at the 18th annual meeting of the American Association of Oilwell Drilling Contractors, Dallas, Texas, October 3, 1958.

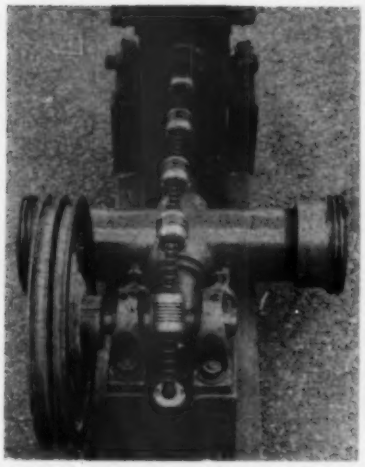

FIG. 3. **Sprocket assembly** of the solids injector. Each revolution of the injector sprocket injects 0.12 lb of calcium stearate. Amount of the injection is gaged by the speed of the prime mover.

which drives a pair of sprockets, forming a part of a conveyer-chain assembly. These sprockets, A and B, are designed to accommodate a chain made up of a series of equally spaced pistons, C. Since one sprocket is located in the supply hopper, D, containing the antiballing material, the chain-piston combination serves as a conveyer. As the sprockets rotate, the antiballing material is picked up between the pistons and carried through the inductor tube, E, into the flow line, F. Each piston contains a set of pressure actuated seal rings, G, which effect a seal in the inductor and eductor tubes, E and H, against line pressure. The conveyer-chain assembly is designed such that the spacing between the pistons permits two units to be in both the inductor and eductor tubes at all times. This arrangement affords a double seal to loss of line pressure to either the supply hopper or to atmosphere. While the volume between successive pistons is fixed for any particular unit, the quantity injected may be varied by changing speed of rotation of sprocket conveyer chain assembly. A bleed valve assembly, I, is incorporated in the eductor tube, H, to relieve the line pressure which is confined between the two pistons.

In field operation, the unit is normally installed between the air or gas source and the rig standpipe. The quantity to be injected is regulated by varying the speed of the prime mover. Each revolution of the injector sprocket injects 0.12 lb of calcium stearate. No attention is required for the operation of this unit other than affording normal lubrication to the engine and drive sprockets and checking frequently to insure free movement of granular or power material in the supply hopper.

for
sand...
abrasion...
temperature...

This pump is especially efficient in wells with excessive float sand, dirty fluid, or high bottom-hole temperatures because the three concentric, free-fitting tubes use well fluid for the plunger seal. The plunger is also free-falling, which allows a faster pumping rate without being hard on the rods. H-F 3-Tube Pumps are fitted out to A. P. I. specifications, including standard balls and seats. Either regular or on-and-off types are available in 2" x 1¼", 2½" x 1¼", and 4"x3¼" sizes, and in 12' to 25' lengths. For hard-to-pump wells—or as a good, all-around pump for average wells—you can depend upon the H-F 3-Tube to make good production without frequent pulling jobs.

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Natural Gas and Oil Company reports...*

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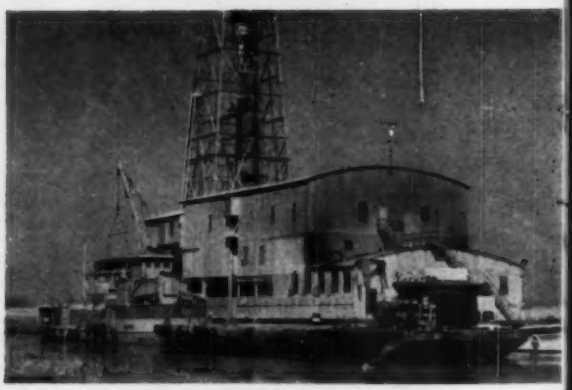


DRILLING BARGE RAY TERRY is shown on location in the East Golden Meadows area of Louisiana. Greater efficiency of G-E Drive has enabled Natural Gas and Oil Company to drill more hole at less cost.

NATURAL GAS AND OIL'S "RAY TERRY" has set an outstanding performance record since it was put into service. During a recent six-month period, this barge, equipped with a General Electric Drive System, drilled four holes—all over 12,000 feet. Virtually no down time or maintenance was attributed to the G-E Drive.

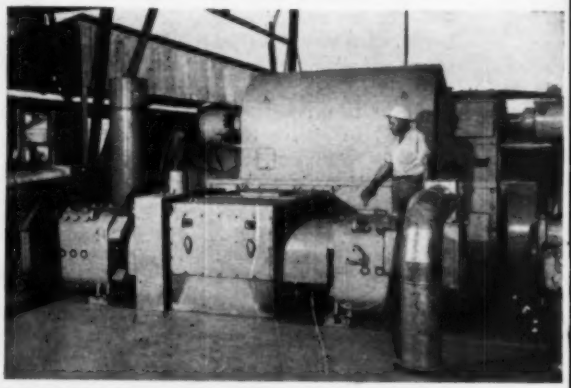
"WE ARE EXTREMELY SATISFIED WITH THE G-E DRIVE on our Ray-Terry barge and, based on the equipment's highly successful performance during the past year, we could not have made a better purchase." This sums up how Natural Gas and Oil Company management feels about their first operating experience with General Electric Drive.

MANY OTHER CONTRACTORS AND OPERATORS have also found that G-E Drive provides faster, more efficient drilling. Electric drive delivers 10 to 15 percent more engine-output horsepower to the drilling task than other types of rig drives. Instantaneous flexibility of power assignment is available to the driller merely by moving the selector switch on his control console. The faster, more efficient drilling provided by the G-E Drive System adds up to more hole at less cost.

DRILLER HAS POSITIVE DRILLING CONTROL at all times. Ray Terry drillers report that G-E controls are simple to understand and easy to operate, allowing greater command over drilling functions.

FOR MORE INFORMATION ABOUT GENERAL ELECTRIC DRIVE and how its advantages can benefit your drilling operations, whether on land or offshore, call your nearest G-E Apparatus Sales Office. Drilling offices are located in Dallas, Denver, Houston, Los Angeles, New Orleans, and Tulsa; in Canada: Calgary and Toronto. For overseas requirements, International General Electric drilling offices are in Bogota, Buenos Aires, Caracas, Maracaibo, Mexico City, Puerto LaCruz, and New York. General Electric Company, Locomotive and Car Equipment Department, Erie, Pa. 115-29

*Natural Gas and Oil Company, a Division of Mississippi River Fuel Corporation.



DRAWWORKS DRIVEN BY TWO GE-752 DRILLING MOTORS enables the rig to drill to depths of over 20,000 feet. General Electric's service-proven drilling motors and generators require little maintenance, help reduce drilling costs.

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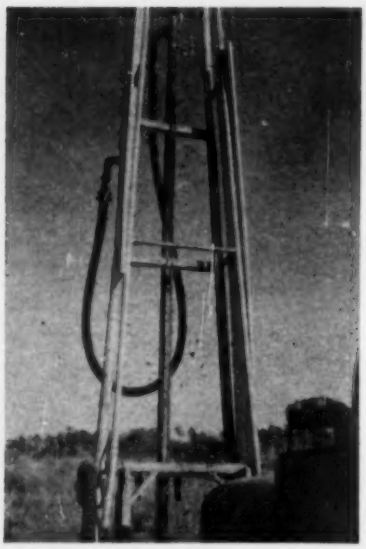
GENERAL ELECTRIC

Here are several "rig-tested" . . .

DRILLING IDEAS at WORK

Leg of Derrick Serves as Stand Pipe

● Drilling shallow wells, a savings can be made in piping by using one leg of the derrick as a stand pipe to take the drilling mud half way up the derrick. A connection for the hose from the



mud pump is made at the base of the derrick and then the connection for the rotary hose is welded on half way up the derrick.

By using this arrangement, the stand pipe becomes an integral part of the derrick and cuts down the load when the derrick is moved over the road. When it is time to rig up, the derrick is raised and the rotary hose hooked up to the swivel without other connections being necessary.

Pipe Racks are Nested Into Handy Package

● These three pipe racks are built so that they will make one easy load. The racks are set side by side after they are unloaded. The two outer racks are then pivoted up toward the middle and the tops of all three are tied together. When it is time to move, they can be picked up in one load. Also, the ends of the top pieces have been sliced off so that they will fit into one another and make it easy to roll pipe.

Bars and Wing Bolts Seal Mud Gates

● It is usually quite a problem to get mud tank gates to seal without having a lot of bolts and gaskets to use in doing so. Here is a very simple idea for achieving a good seal. Two bars fitted with 2 wing bolts each are hooked behind 4 lugs welded to the tank. It takes only a minute to loosen the wing bolts which press against the mud gate itself. A gasket the full size of the gate is one that will not be torn up or lost. This gate can be made up by a rig welder.

SEASONS GREETINGS

WE FEEL THAT THIS YEAR SHOULD NOT PASS WITHOUT OUR EXPRESSION OF FRIENDSHIP. WE WISH YOU AND YOURS A HAPPY AND PROSPEROUS NEW YEAR

FLUID PACKED PUMP CO.
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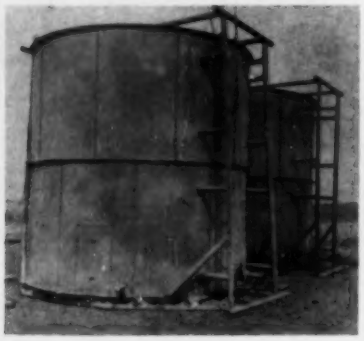
DRILLING IDEAS at WORK

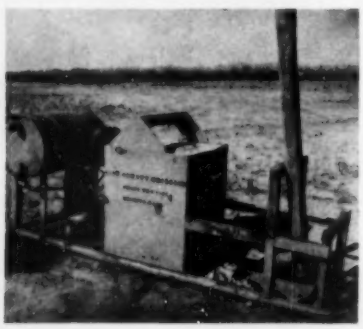


Simple Pipe Frames Ease Tank Moving

● Here is a good way to rig up water tanks for easy moving. The frames are made of 3-in. pipe and the vertical pieces are spaced so that they will fit onto the truck beds. When it is time to move, a winch line is thrown around the cross member at the top and the tank is flopped down over the truck and hauled to the next location. If the well is in the same field, the tank need not be loaded completely and is easily set back down at the new location.

Portable Forge Unitized For Quick Operation

● A forge for heating cable tool bits may be arranged into a package unit by mounting the box of bricks in the center of a pipe support and fixing a place for the bits on one end and a support for the fuel tank and blower on the other end. The bit end is rigged up with a trough for quenching the bits and a roller for sliding the bits in and out of the forge. A chain is usually thrown around the upper piece of angle



iron to support the bit when it is packed with mud around the end in the forge.

The blower end has an electric motor mounted on the side of the box of bricks and belted to a blower which is on the 2-in. skid base. Fuel and air are blown directly into the face of the bit surface for efficient heating. A half-inch needle valve on the bottom of the drum controls the rate of entry of fuel into the forge.

Safety Line On Mud Discharge Hose

● Here is a way to prevent serious injury to a workman who might be near the front of a mud pump should the mud hose blow off. A heavy-duty clamp is made up for the hose. The

clamp is attached to the discharge channels of the pump by a piece of cable pulled up snug to prevent any travel of the hose should it blow off.

Carpet Sweeper Helps Dress Small Bits

● A Kansas driller has adapted a simple carpet sweeper to provide a hot flame for dressing the small drill-in bits used on a rig which follows the rotaries. He made a small hole in the ground and connected the carpet sweeper to a piece of 2-in. pipe with the gas inlet on the side of the pipe. With a flick of the sweeper switch, he can make a blue flame for proper heating of the bits.

Steam Coil Prevents Freezing of Lines

● Lines leading from water tanks can be protected from freezing by installing a steam coil beneath the valves and lines. The coil is formed from branches of pipe between two headers. The main steam supply is run through the coil on the way to the rig, thus assuring continuous operation and protection for the water lines.

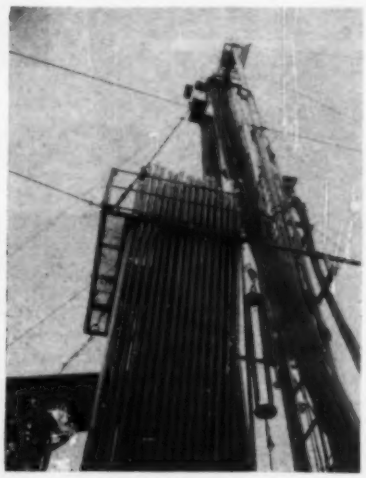
Shopmade Rack Holds 8500 Ft of Rods and Tubing

● A collapsible mast was rigged up by a Gulf Coast producer to accommodate 8500 ft of 2½-in. tubing and rods. The mast is 73 ft tall and is designed to lay down over the top of the truck cab.

The racks are made of 2-in. pipe which is hinged behind the mast. After the rig is up, the boards are lowered and caught by cables which connect from the outside of the boards to the top of the mast. The cat-walks are made by putting steel grating in the space near the outside of the racks as shown.

Tubing is racked in singles with 9 rows of 16 joints in each row.

Rods are hung in doubles with 7 rows on each side and 11 doubles to the row. This rig considerably shortens the length of time to make round trips during workover operations.



WHELAND HP-18000
DUPLEX POWER SLUSH PUMP
7¾"x18" 750 HP NOMINAL INPUT at 60 RPM

WHAT IS THE *OPTIMUM* PUMP FOR YOUR JOB?

You consider the pressure and volume needed, the weight and cost of moving the pump, the cost of power to drive it and your initial investment.

More and more men who know how to use big pumps are coming to the studied practical conclusion that a 600 to 750 hp input pump is **OPTIMUM** for their operations.

The Wheland HP-18000 pump gives you up to 826 gpm and 1,322 psi with 7¾" liners and up to 388 gpm and 2,700 psi with 5½" liners. It weighs only 36,377 lbs., is easily moved in one piece, is rated at 750 hp at 60 rpm, has six big features combined on no other pump and a top record for performance and dependability.

Detailed bulletin sent on request.

It will pay you to see if this isn't the *OPTIMUM* pump for your job, too!

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CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

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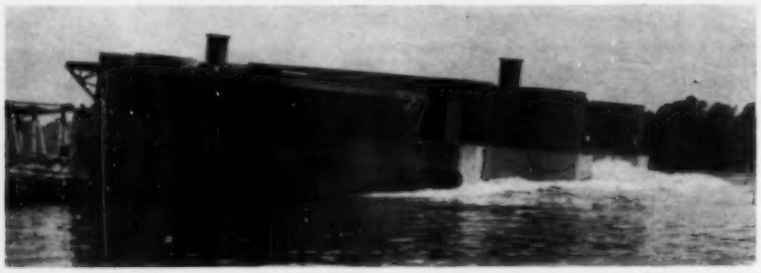
What's doing in DRILLING

'Mr. Louie' Launched for Gulf Drilling



One of the latest offshore drilling platforms to join the Gulf Coast fleet recently slipped down the ways of the Port Houston Iron Works yard in Houston, Texas. The platform, owned by Universal Drilling Company, Inc., of New Orleans, is a single hull, self-elevating, 12-leg supported unit. After the platform is towed to location, the 12 caissons are lowered and the platform is jacked until it climbs to a point 40 ft above the water, and the unit is ready to drill as many as 9 wells before being moved. Length of the unit is 249 ft, with an overall beam of 133 ft. It is designed to drill in water from 25 to 120 ft deep and is outfitted with a 20,000-ft rig.

Canadian Contractor Offers Slim-Hole Drilling

A new Canadian contractor is specializing in "slim-hole drilling geared for the remote and isolated areas that most everyone would just as soon forget." R. C. Arnim, vice president of the Calgary-based Arnim Drilling Ltd., states that the company will stress operations in the northern Canadian country and in Alaska. Using a special trailer-mounted rig, the entire unit can be moved in eight relatively light loads, permitting the rig to be moved and drilling to continue even after "break-up" of the muskeg. President of the company is J. K. MacMillan.

Calvert Drilling Buys Tulsa Drilling Firm

The drilling equipment and other facilities of Mercury Drilling Company, Tulsa, Oklahoma, have been purchased by Calvert Drilling, Inc., of Oklahoma City and Tulsa. The acquisition adds to Calvert's properties two 12,000-ft rigs, Mercury's yard and warehouse facilities at Lindsay, and a large stock of new and used drill pipe, casing, and tubing. Mercury will continue as a producing company and will continue development in Oklahoma and south-central Kansas, according to Doyle Cotton, Mercury president.

Drilling Injury Rate Declines

The injury frequency rate for the drilling industry has declined from 54.97 in 1947 to 30.95 in 1957. So noted C. W. Alcorn, executive vice president, Falcon Seaboard Drilling Company, in an address to the annual meeting of the National Safety Congress at Chicago. Alcorn told delegates, "Insurance rates have gotten so high over the past 10 years every contractor has had to take a closer look at his records and I believe that surely this closer look and the action that followed is the reason for these decreases." Severity rate of injuries has decreased from 6.40 to 4.64 during the 10-year period.

Glasscock-Tidelands Sold to Murmanill

Purchase of control of one of the largest offshore drilling concerns has been announced by Murmanill Corporation of Dallas. The company purchased is the C. G. Glasscock-Tidelands Oil Company of Corpus Christi, Texas. The firm operates 14 rigs, most of which are barge-mounted and the largest of which is aboard "Mr. Gus Number 2."

Present management of Glasscock will continue to operate the organization. In addition to its drilling operations, Glasscock owns extensive oil and gas properties in southern Louisiana and Texas.

Gulf of Paria Deep Test Abandoned

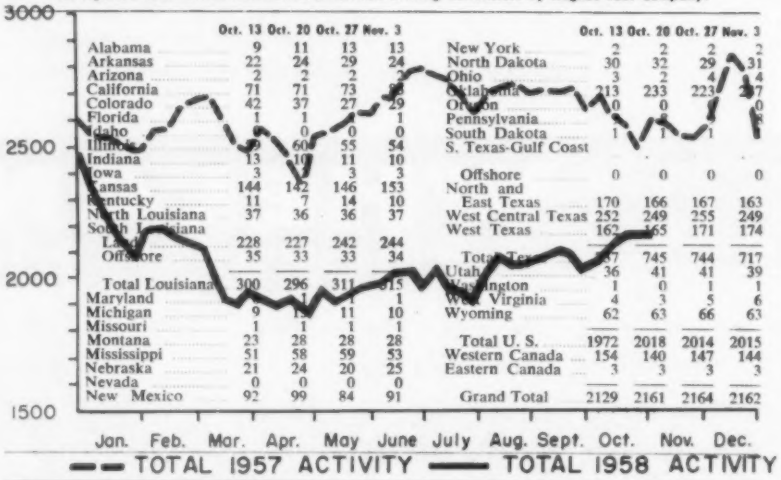
An exploratory well in Trinidad, believed to be the deepest ever drilled from a floating barge, has been abandoned as dry at a depth of 10,814 ft, according to an announcement from Standard Oil Company of California. A Standard operating company, the Dominion Oil Company, drilled the well as operator with the Offshore Company of Baton Rouge, Louisiana, as drilling contractor.

The well, located in the Gulf of Paria, was set with 13⅜-in., 10¾-in., and 7-in. casing, the latter at 7320 ft. Drilling time was 4 months and 18 days.

Rotary Rigs Operating in Oil Fields of United States and Canada

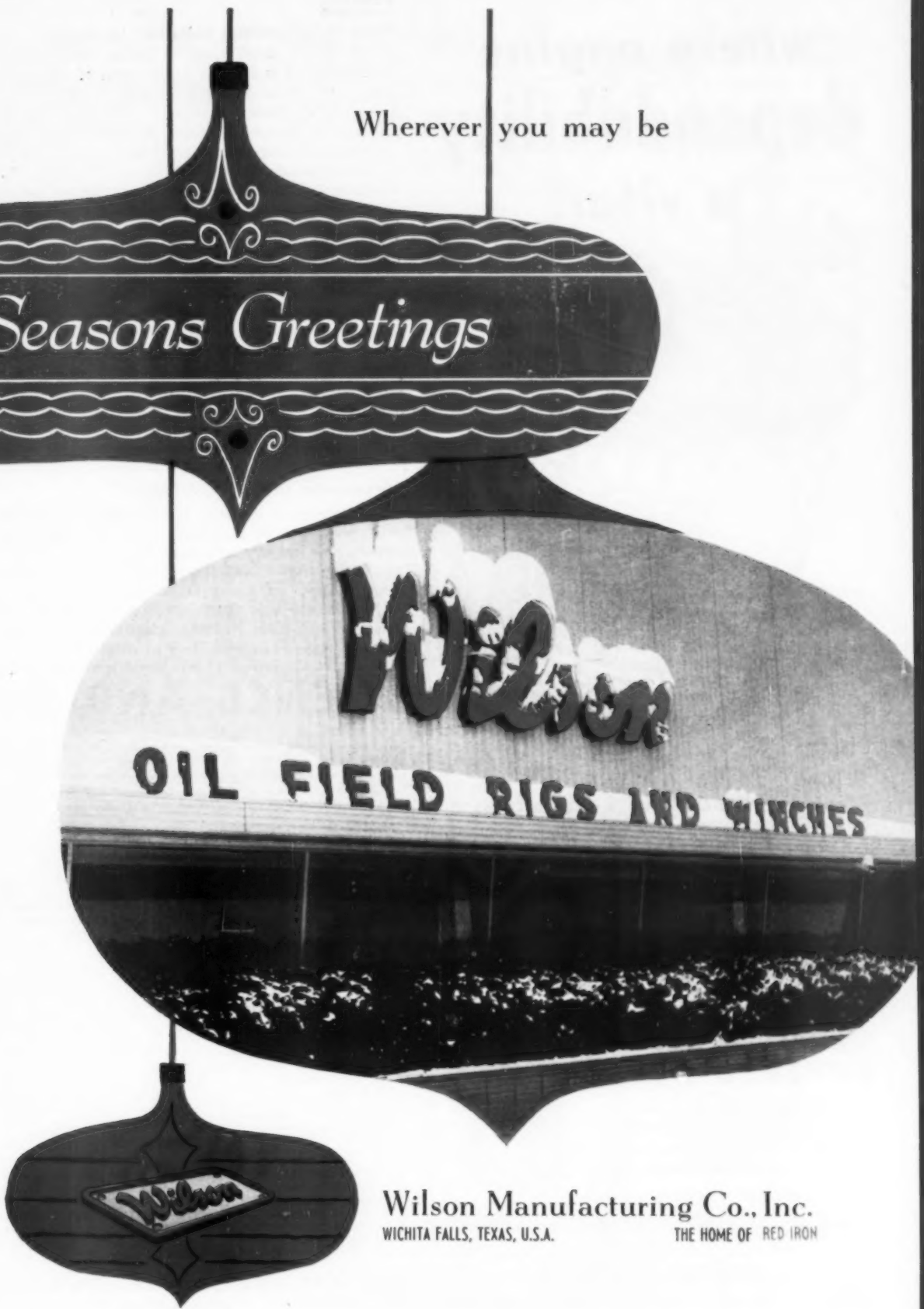
As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	Oct. 13	Oct. 20	Oct. 27	Nov. 3
Alabama	9	11	13	13
Arkansas	22	24	29	24
Arizona	2	2	2	2
California	71	71	73	68
Colorado	42	37	27	29
Florida	1	1	1	1
Idaho	0	0	0	0
Illinois	59	60	55	54
Indiana	13	10	11	10
Iowa	3	3	3	3
Kansas	144	142	146	153
Kentucky	11	7	14	10
North Louisiana	37	36	36	37
South Louisiana				
Land	228	227	242	244
Offshore	35	33	33	34
Total Louisiana	300	296	311	315
Maryland	1	1	1	1
Michigan	9	11	11	10
Missouri	1	1	1	1
Montana	23	28	28	28
Mississippi	51	58	59	53
Nebraska	21	24	20	25
Nevada	0	0	0	0
New Mexico	92	99	84	91
New York	2	2	2	2
North Dakota	30	32	29	31
Ohio	3	2	4	4
Oklahoma	213	233	223	227
Oregon	0	0	0	0
Pennsylvania				
South Dakota	1	1	1	1
S. Texas-Gulf Coast				
Offshore	0	0	0	0
North and East Texas	170	166	167	163
West Central Texas	252	249	255	249
West Texas	162	165	171	174
Total Texas	587	745	744	717
Utah	36	41	41	39
Washington	1	0	1	1
West Virginia	4	3	5	6
Wyoming	62	63	66	63
Total U. S.	1972	2018	2014	2015
Western Canada	154	140	147	144
Eastern Canada	3	3	3	3
Grand Total	2129	2161	2164	2162



Wherever you may be

Seasons Greetings



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TO BE SURE OF "ROUND-THE-CLOCK" PROTECTION.
Feeds MARVEL Mystery Oil in exact proportion to engine speed and load.

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MARVEL DIVISION
EMEROL MFG. CO., Inc. • 331 North Main Street, Port Chester, N. Y.

Drilling

Navy to Sell Drilling Tools Left in Alaska

The Navy's supply depot at Seattle, Washington, has been instructed to expedite a public sale of drilling equipment, worth about $200,000, located at Wolf Creek, near Umiat, in the Alaska naval petroleum reserve. Equipment will go to the highest bidder and will be sold in one package. Inventory of equipment is available at the Seattle supply depot and includes five operable rigs and a number of small core-hole rigs. Interested persons can examine the equipment although only access to the area at present is by ski planes.

General Petroleum Sells Drilling Equipment

General Petroleum Corporation, Los Angeles, is selling its drilling equipment and hereafter will have its work done by contractors, says Robert L. Minckler, president. The company is spread over the west coast and the Rocky Mountain area. Minckler explained it has become "increasingly uneconomic to find employment for our own company tools.... In making this change, we are following the practice which has become increasingly the standard procedure in the oil industry."

Venezuelan Drilling to Increase

A "tremendous increase" in oil drilling and production in Venezuela within the next 5 to 10 years along with an expansion of the country's general economy is forecast in a company report made by Arthur J. Heiser, vice president in charge of Brown Drilling Company. The report emphasized the importance of maintaining continued good relations with Latin America against the day "when the Western Hemisphere may have to stand alone."

SCIENCE AND OIL

Science has overtaken the "dowsers" and the "doodlebuggers". WE ARE BRAGGING; for, after long research, experimenting and testing, we have completed our new reconnaissance instruments, in connection with our Attractometer, which cuts time and cost of our surveys and vastly improves our services to our clients, by shortening the route to petroleum reserves. Our services could well be the difference between success and failure of your wildcat venture.

QUOTES, IN PART, OF LETTERS RECEIVED FROM SOME OF OUR CLIENTS.
(Brochure and copies of letters on request.)

"The surveys which you ran for us in Wyoming were so accurate, we would be afraid to drill a well without using your Attractometer. The third well where we drilled, using your Attractometer, seems to be a successful undertaking. We hit 12 feet of sand and have set pipe. The second well is pumping over 100 barrels and the first, of course, is flowing over 100 barrels per day on a 11/64 choke."

"It pleases me to say that your report was correct, unbelievable as they may seem."

"Three surveys recently completed by you for this company were without error."

"I would certainly hate to drill a well where this geophysical work had been done, which showed no oil accumulation. I feel it is the greatest development in geophysical research that has been discovered."

Specimen of logs indicating saturation

"We cannot stress too strongly the fact that we would only be interested in drilling where your surveys show good potential."

"I am getting ready to test the second well we have drilled this spring. The first one came in very good."

"We highly recommend the use of the Attractometer before any drilling is done."

THIS IS OUR 23RD YEAR OF SERVING THE WILDCATTER AND OIL MEN OF THE COUNTRY, AND IF NEAR BY, WE WILL SURVEY YOUR RANK WILDCAT TEST DRILLING OR TO BE DRILLED FREE AS PROOF OF THE ACCURACY OF OUR WORK, AND MAKE A PERMANENT GRAPH-LOG INDICATING POSSIBLE SATURATION, IF ANY, UNDERLYING THE LOCATION AND AT APPROXIMATELY WHAT DEPTH IT MAY BE FOUND. AMPLE FUNDS FOR DEVELOPMENT WHERE GOOD LOGS ARE OBTAINED AND DEAL IS REASONABLE.

GEOPHYSICAL SURVEY SYNDICATE
4133 SUNNYSLOPE AVENUE • SHERMAN OAKS, CALIFORNIA • STATE 4-6903

Simpson Re-Elected IPAA President

Gordon Simpson, president of General American Oil Company, has been re-elected for a second one-year term as president of the Independent Petroleum Association of America. Other major officers were also re-elected at the IPAA's 29th annual membership meeting in Dallas, Texas, October 27-28.

Russell B. Brown, who recently announced his retirement beginning in 1960, was again named as general counsel of the organization for 1959. Others to hold their positions for another year include Minor S. Jameson Jr., executive vice president; W. L. Kistler Jr., treasurer; and I. C. Huff Jr., executive manager and secretary.

Attendance Up!

A trend in declining oil association meeting attendance was reversed when some 1200 registered for IPAA's meeting. The number exceeded pre-registration estimates by 200.

The meeting was highlighted by many well known oil industry and government leaders and top men in related fields.

Imports Panel

Of primary interest at the independents' gathering was a six-man panel discussion of the government's revised voluntary oil imports program. Questions concerning the program were put to Roland A. Whealy, assistant to federal oil imports administrator Matthew V. Carson. On the panel were George Myers, vice president of Standard Oil of Indiana; Lester Clark, Daniel & Clark of Breckenridge, Texas; John Houchin, vice president of Phillips Petroleum; Rushton Ardrey, senior vice president of Republic National Bank of Dallas, and Paul R. Schultz, Blackwell Oil and Gas, Tulsa.

The proposed refinery-run-based plan met with both criticism and praise from the panelists.

The IPAA, acting through its imports policy committee, reaffirmed its endorsement of the new plan in a meeting held just prior to the general sessions, but asserted its position that the program must also include products.

Top-Brass Speakers

Other notables speaking before the IPAA included Senator Lyndon Johnson of Texas, majority leader of the Senate; C. R. Smith, president of American Airlines; Jake L. Hamon, Dallas independent oil producer, and Elmer F. Bennett, undersecretary of the Department of Interior.

Russell Brown, in the general counsel's report to the membership, called for a five-point program for the association to meet the expected challenge during the coming year to percentage depletion.

Depletion Dilemma

Brown cited developments in the senate during the past session as "an ominous warning of what to expect next year." To meet this expected threat to the tax provision, he suggests that the association:

1. Encourage academic studies by college faculty members so as to obtain an objective analysis from disinterested sources;
2. Designate personnel in the Washington IPAA office to devote full time to statistical studies and development of a program of action;
3. Organize a program of understanding and support through various civic, business and industry-related organizations;
4. Confer with groups unfavorable to industry's position on depletion with a view of correcting their point of view;
5. Emphasize the industry's position in regard to percentage depletion through the IPAA public information program.

* * *

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2. CAP SHOE
3. TOE
4. Or at any point using chain as a sling
This SIMPLEX Jack solves close quarter jacking problems. Dependability and speed for jacking mobile equipment and skidding rigs. Tilts on base for angular jacking. Awarded the only Gold Medal for Safety. Send for OIL BULLETIN TODAY!
WORLD'S LARGEST MECHANICAL AND HYDRAULIC JACKS
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EXPLORATION ACTIVITIES

ARKANSAS

Arkla Gas Begin Tests in Desha Basin Area

Arkansas Louisiana Gas Company has begun wildcat drilling operations in the Desha Basin of southeast Arkansas with a 6800-ft slim-hole test in Chicot County.

The utility has assembled a large group of leases in Drew, Ashley, Chicot and Desha counties. The 120,000-acre lease block is approximately 30 miles in length and varies in width from one to four miles. The first wildcat is in Sec. 7, T15S, R2W, Chicot County near Lake Village. Four others are to be drilled. Exploration in southeast Arkansas is based on similarity of the geological formations to those which produce so prolifically in southwestern Arkansas and north Louisiana. Important zones that will be tested include the Tuscaloosa, productive in the Delhi field of northeast Louisiana, the Travis Peak sands which account for gas production from ALG's Calhoun field, in north Louisiana, and the Smackover lime which produces oil and gas from many of the big fields in both states.

A relatively new rotary drilling technique known as slim-hole drilling will be used by ALG. Small, extremely mobile drilling equipment using light weight, hi-grade steel drill pipe developed in recent years by the oil and gas industry permits rapid drilling and fast moving from one location to another.

SASKATCHEWAN

Firms to Drill 8 'Cats In Search of Midale Pay

Devon-Palmer Oils Ltd., Renwar Oil Corporation of Corpus Christi, Texas, and William I. Lee of Waco, Texas, have commenced drilling on two of eight wildcat wells to be drilled in southeastern Saskatchewan.

Eight wells are to be drilled in areas where the productive Midale formation has been successfully developed during the past several years. Each is to test the Midale and Mission Canyon formations. The wells will be located on farmouts acquired from Imperial Oil Ltd. It is understood that by the drilling of the eight wells, the group will earn approximately 5760 acres, subject to an over-riding royalty reserved to Imperial Oil.

The first well, was spudded November 5. Surface casing has been run and the well is drilling ahead.

Drilling contracts for eight wells have been let to Canamerican Drilling Ltd., a wholly-owned subsidiary of Devon-Palmer. The contractor will use two rotary rigs on the program.

TRINIDAD

Dominion Floating Barge Test Abandoned at 10,814 ft

An exploratory well in Trinidad, believed to be the deepest ever drilled from a floating barge, has been abandoned as dry at a depth of 10,814 ft, Standard Oil Company of California announced. A Standard operating company, the Dominion Oil Company, drilled the well as operator with the Offshore Company of Baton Rouge, Louisiana as drilling contractor.

The well, located in the Gulf of Paria, was set with 13⅜, 10¾ and 7-in. casing, the latter at 7320 ft. Drilling time was 4 months and 18 days.

AUSTRIA

Companies Act to Boost Declining Reserves

Several oil companies, among them The British Petroleum Company, are now prospecting for new oil reserves in Austria. BP is doing so through a joint venture with the OMV, the Austrian State Oil Administration.

Agreement on the formation of this venture, known as the Arbeitsgemeinschaft OMV/BP was reached in 1957. After preliminary geological studies, a seismic survey in the Scheibbs area in Lower Austria was begun in the spring of this year. The survey is being carried by a contract party and is expected to last six months. The joint venture, in which BP's 50 percent share is held through BP Exploration Company, covers at present only the two small concessions of Scheibbs and Amstetten —a total area of about 2000 sq km— but the agreement provides for extension to other areas if these become available.

CALIFORNIA

Another 'Golf Course' Discovery In Los Angeles Area

An exploratory well has been completed on Hillcrest Country Club in West Los Angeles, by Signal Oil and Gas Company and Richfield Oil Corporation. Signal is the operator.

The well, Signal-Richfield-Hillcrest No. 1, flowed 33 deg clean oil at the rate of 750 bbl per day and 470,000 cu ft of gas per day. The test was made in a 682-ft interval at an approximate depth of 9500 ft. Tubing pressure was 550 psi.

The well is the first to have been drilled as a test of the 140-acre private golf course. Signal-Richfield-Community No. 1, drilled directionally from Hillcrest to a bottom-hole location under an adjacent residential area, was suspended pending installation of testing facilities.

On neighboring Rancho Park golf course, where Signal discovered a new oil producing area in September, Signal-Richfield-Rancho No. 2 is drilling below 5700 ft.

Bandini, Hamilton Join San Emidio Nose Activity

Bandini Petroleum Company and Hamilton Dome Oil Company, Ltd. are drilling on their Johnson lease in the San Emidio Nose area in Kern County.

The test well, which is located in Sec. 32, T12N R21W, SBB & M, falls about a mile north of Richfield's recently-completed KCL 81-8 and a mile and a half north of Richfield's KCL 34-9, the discovery well in the area. A 12,000-ft Reef Ridge test is planned.

The companies jointly own leases covering approximately 1100 acres in the San Emidio Nose area. Forty-five percent of the acreage is within 1½ to 2½ miles of the recently-announced discovery well of Richfield Oil Company.

CORRECTION

In the October 1958 Drilling Progress Report of The Petroleum Engineer's Drilling and Producing Edition, the article entitled, "Fluid Knock in Mud Pumps" carried the byline as follows: Samuel L. Collier, Houston Manufacturing Company, Houston. The company affiliation as printed is in error and should have read: Samuel L. Collier, Mission Manufacturing Company, Houston.

Flight Into Inner Space

It will never happen — during our lifetime.

On-the-spot studies of the moon will become academic long before "entry" through the earth's crust is attempted — *if ever.* Routine air travel takes babes in arms higher than man has contemplated journeying below.

Even as petroleum celebrates its one-hundredth year, the only means of obtaining *material* evidence from subsurface formations is through coring and core analysis. *Yet, how realistic!*

As targets for discovery become less defined, and as the economic necessity for establishing optimum recovery procedures becomes more critical, can you afford not to use core analysis?

True, there are several other methods of evaluating a formation — mostly at the end of a wire line. Each has its proper application at the appropriate time — but only after core analysis has turned the key. (Proof of performance by these secondary tools is sustained with *"core analysis data on samples from the same well, etc."*).

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Exploration

NEBRASKA

Drilexco Makes Second 'J' Sand Discovery

A second discovery is being completed by Drilling and Exploration Company, Inc., et al. Latest discovery is in Sec. 23, T13N, R55W, in the Enders Area of Kimball County, Nebraska. The No. 1 Hawthorne is being completed as a "J" sand discovery.

After fracturing, this well swabbed at the rate of 15 bbl of oil per hour for 20 hours from perforations at 6284-6288 ft, and from 6303-6305 ft. Tubing and rods are now being run preparatory to final pumping tests.

Drilexco owns a one-fourth undivided interest in a block of approximately 2500 acres which includes the well tract. This wildcat is situated about 2½ miles southwest of the No. 1 Forest Hinshaw, another discovery well reported by the company recently.

TEXAS

Dual Strike in Andrews County Flows 739 Bbl

The Texas Company's State of Texas "CR" No. 1 in Andrews County, was completed as a dual producing oil well, which discovered new Fusselman production and extended the east flank of Ellenburger production half mile. Combined flow from the two horizons was reported as 739 bbl daily.

On a 24-hour potential test, the Texaco well flowed 320 bbl of 45.6 deg oil from perforations at 11,683-717 ft in the Fusselman through an 18/64-in. choke. Tubing pressure was 800 psi, and the gas-oil ratio 1452 to one.

From perforations at 12,490-510 ft in the Ellenburger, the well flowed 419 bbl of 49.3 deg oil daily through a 14/64-in. choke with tubing pressure of 725 psi. The gas-oil ratio was 467 to one.

Location of the State of Texas "CR" No. 1 is 10 miles south of Andrews.

LIBYA

Second Successful Well For Oasis Oil

A second successful wildcat oil well is being completed by Oasis Oil Company of Libya. The well, No. B1-32 Dahra, located 24 miles south of the company's initial Libyan discovery, had 38 bbl of 36 deg oil with no water in an hour and 15 minutes on a drill-stem test. The exploratory well tested an interval from 3758 to 3808 ft in a limestone formation.

Oasis Oil, a wholly owned subsidiary of the Ohio Oil Company, is operator of 62 million acres of concessions in Libya, North Africa, held in undivided one-third interests by Ohio Oil, Amerada Petroleum Corporation and Continental Oil Company.

The apparent discovery is on the south end of the same block in which Oasis Oil of Libya's No. 1 Bahi tested 75 bbl of 39 deg oil in 2½ hours late in June. Interval tested in the first well was considerably lower, a 32-ft standstone section from 5822 to 5854 ft.

The wells are located on Concession 32 comprising a block of 1¼ million acres. The first well is located approximately 75 miles and the second 100 miles due south of the Gulf of Sirte.

KANSAS

White Eagle Finds New Pay in Kearny County

White Eagle Oil Company of Tulsa has reported the development of a new pay zone in its Pleasant Prairie area in southwestern Kansas. The new zone is the Kansas City-Lansing Lime which was tested in White Eagle's USA No. 14-1 in the NE/4 NE/4 SW/4 of Section 14-26S-35W, in the Southside Pool, Kearny County, Kansas. The well was perforated from 4129 to 4142 ft and after acid treatment swabbed 24 bbl per hour. After being put on the pump the well made 104 bbl of oil per day which was the capacity of the pump.

The USA No. 14-1 was originally completed in September 1957, in the Mississippian formation, the pay zone from which White Eagle's 22 other wells in the area are producing. Two rigs are at work on the company's 25,000 acre block.

BRITISH HONDURAS

Phillips to Spud First Central American Venture

Phillips Petroleum Company has acquired three blocks of oil and gas leases and prospecting licenses totaling approximately 2,000,000 acres in southern British Honduras, marking the company's first entry into Central America. The rights were secured from Bandini Petroleum Company, Belize Petroleum Company, Ltd., and West Caribbean Oil Company, Ltd.

Phillips is beginning geological and seismic surveys of the acreage, which is both on land and in shallow, protected offshore waters. The company plans to start drilling an exploratory well this month at a location to be determined by the initial geological and geophysical work.

USSR

Caspian Sea Seismic Surveys Run at 650 to 1650 ft Depths

Russia has launched a stepped-up program of oil exploration in the Caspian Sea, with emphasis on underwater areas east of Azerbaijan, a report in *The Moscow News* states.

The Azerbaijanian Administration for Geophysical Marine Oil Prospecting says its new diesel ship, the Bora, is being equipped with a seismographic station, a radio-geodesic installation "and various other advanced instruments permitting investigations at great depths in the Caspian." Studies this year will be concentrated in the central Caspian in the vicinity of the Apsheron Ridge and near the coast of northeastern Azerbaijan.

Seismic investigations are to be conducted at depths of from 650 to 1650 ft. Previous Soviet marine oil prospecting in the Caspian was limited to a maximum depth of 260 ft at distances no more than 25 miles from the coastline.

FRANCE

Alps Seismographed; Oil Companies Participate

During September a series of explosions ranging from 200 lb to about 20 tons of dynamite were detonated in a lake in the French Alps in order to allow measurements to be taken of the earthquake type waves that they produce. Teams of observers from France, Germany, Switzerland, Italy and Great Britian recorded the waves at distances of up to 150 miles. From the travel times that are observed it is hoped to obtain a picture of the rock layers that form the roots of a great mountain chain. Seismic instruments were spaced out along three lines, two running from France to Switzerland and one from Italy into Switzerland.

MALTA

First Deep Test Well Begun by BP Exploration

Drilling of the first deep test well in Malta by BP Exploration Company began in September. The well, near the village of Naxxar about 4 miles northwest of Valletta, will be known as Naxxar No. 2. A shallow exploration well was drilled in the vicinity in 1955. A drilling rig capable of reaching a depth of 15,000 ft has been brought from Sicily. Early this year the Maltese Government granted BP a new license to explore for oil in the Maltese Islands. Previously the company had carried out under license a geophysical survey of Malta.

RUNNING TOUR with MEN in the INDUSTRY

Arnold R. Moore has been named manager of electronic data processing for H. J. Gruy and Associates. Moore brings to Gruy and Associates more than 12 years of engineering, mathematical, accounting and statistical training and experience.

A. R. Moore

J. K. Petty

John K. Petty has established offices as a geological consultant in Farmington, New Mexico. Petty, formerly regional research geologist for Western Natural Gas Company, will offer complete geological consulting service, ranging from subsurface and surface analyses, leasing and drilling, and mineral evaluation and exploration work in the Four Corners area.

Ben C. Belt has been elected to the board of directors of Delhi-Taylor Oil Corporation. He replaces **G. L. Rowsey,** who has resigned for reasons of health. Belt has served the petroleum industry for more than 40 years. He retired in 1955 as vice president and managing executive for the Houston production division of Gulf Oil Corporation.

R. B. Gustafson Jr. has been promoted from senior staff geologist to assistant chief geologist. **Hugo R. Kamb** has been named senior staff geologist for foreign operations. He will be primarily responsible for evaluating foreign exploration situations for Delhi Taylor. Also **P. T. Bee,** has resigned as executive vice president to accept a management position with Murchison Brothers. **C. H. Hobbs** has been appointed to the newly created position of executive assistant to the president. He will continue as corporate secretary. **G. B. Lintner** has been appointed controller in addition to his present treasurer's position. **W. C. Smith,** vice president of production, will coordinate activities of the geological, land, and geophysical departments in the exploration division.

Robert L. Sullivan has been appointed as division gas superintendent for the Southwest production division of Sun Oil Company. **John E. Walke** and **Aubrey V. Hamilton Jr.** also have been appointed as assistant division gas superintendents. Sullivan, previously assistant division gas superintendent, succeeds **Gerald B. Bennett,** who has accepted a position with another company. Walke was formerly division gas engineer and Hamilton was special assistant.

F. A. Lawrence has retired as division superintendent of Cities Service Oil Company's East Texas production operations. He had been with Cities Service for 40 years. **H. E. Massey** has been appointed as district superintendent for that district and **F. D. Priebe** whose duties as division superintendent of Gulf Coast operations, will be expanded to include the East Texas district.

Foster M. Pyle, William H. Davis and **Merle Becker** have formed a new oil company styled Becker, Davis & Pyle, Inc. All were formerly associated with D. D. Feldman Oil & Gas in the respective capacities of manager of production, manager of secondary recovery department and general manager. The office is located in the Meadows Building, Dallas.

C. A. McDowell, a veteran of 50-years in the oil and gas industry, more than 40 of which were spent with Union Producing Company, has retired. He was drilling and production superintendent.

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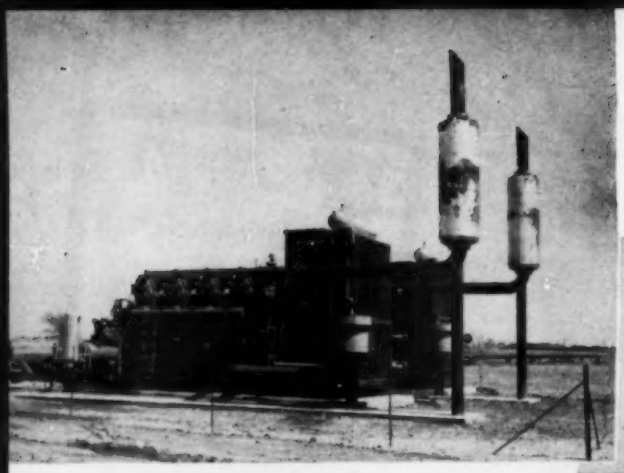

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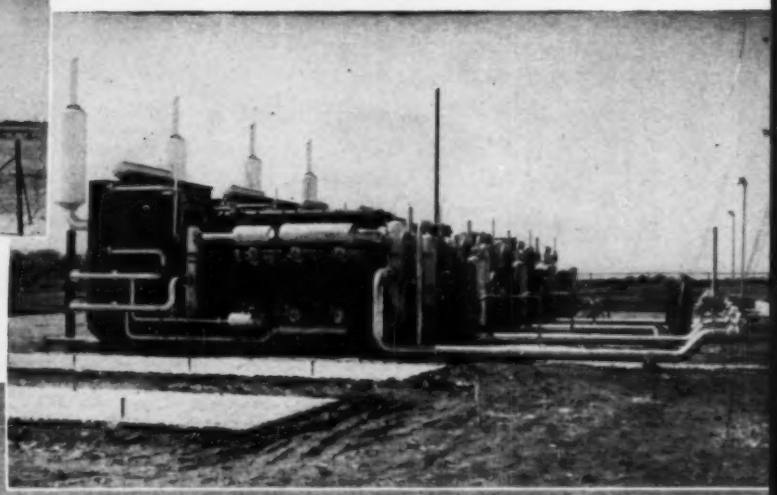

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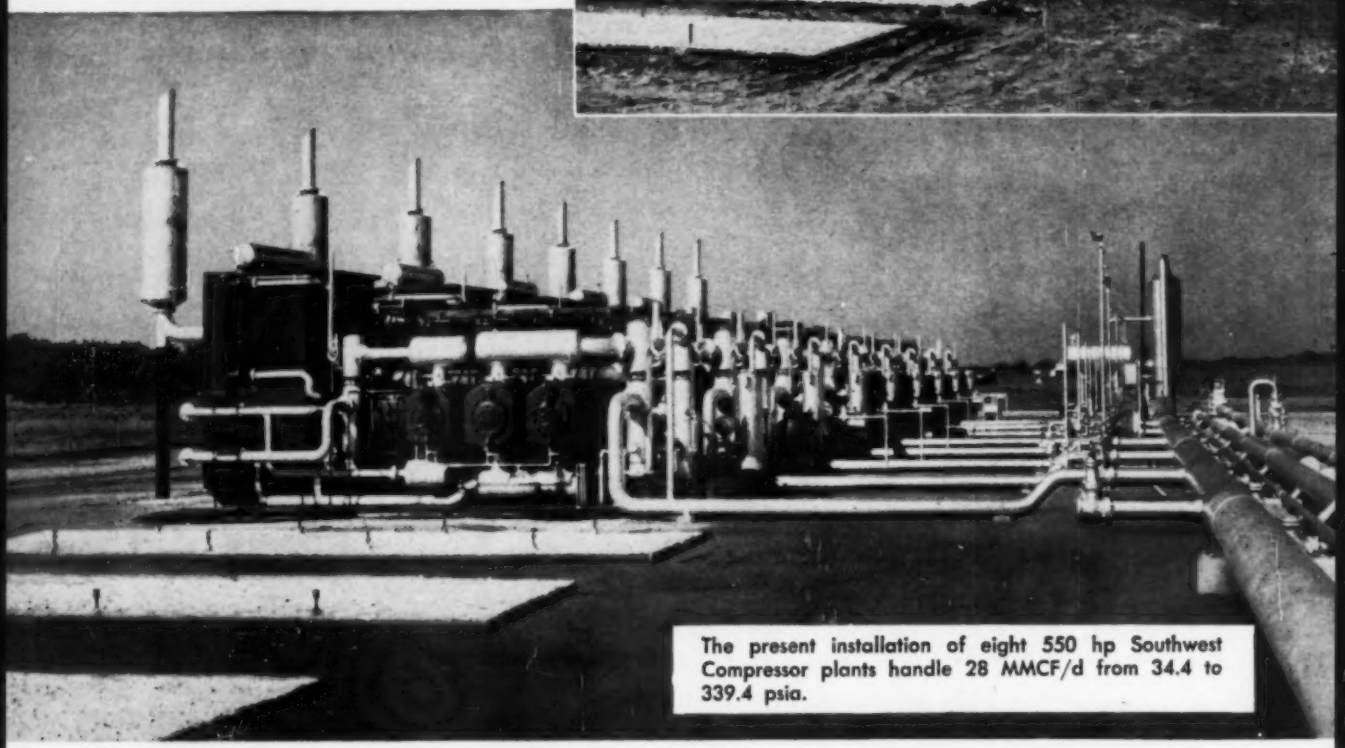

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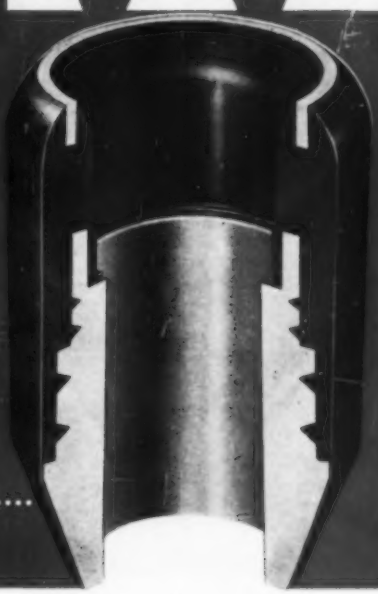

Companion to the Proved E-Z Swab, the new Mark I Cup Swab uses the same mandrel but different rubbers. Mark I is a heavy duty positive displacement type swab able to lift a fluid load of from 1,200 feet to the heaviest loads encountered. Mark I was designed for use where the unique features of the E-Z Swab are not required. Heart of the Mark I—see cutaway—is a solid steel reinforcing core. This solid steel core can't wear, bend, and break as conventional reinforcing wires can. Can't hang up in tubing the way wires can. The new Mark I falls fast and comes out full. All this and the famous Mission Guarantee: "In a competitive test it will outperform all others or your money back." Order through your favorite supply store. Get your copy of the new brochure.

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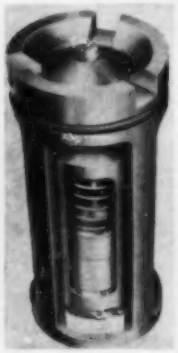
Inclinometer Indicates Deviation in Air Drilling

Sperry-Sun has announced a new instrument for obtaining surface indications of hole inclination during air or gas drilling. The inclinometer is positioned in the float recess directly above the bit and remains in the string continuously. Operation is accomplished by pressure acting against a spring-loaded plunger head. A plumb bob suspended from the plunger head passes through the hole in the orifice and permits full passage of air if inclination is less than the limit. If inclination exceeds the limit, the plumb bob engages a stop which holds the plunger head closed, shutting off flow and causing a pressure buildup indicated at the surface. Available in limits up to 7 deg. *Sperry-Sun Well Surveying Company.*



Circle number (1) on reply card.

Production-Rate Recorder

A new production-rate recorder, made by Odex Engineering, keeps a complete record of flow rates and pump-off conditions, enabling the operator to isolate cases of erratic production. A metal stylus, operated by pneumatic impulse, marks the time each barrel is produced. Clock-driven wax charts require no inking. Re-set counter keeps a cumulative total of production. Works are enclosed in a dust-tight case. *Odex Engineering Company.*

Circle number (2) on reply card.

Composite Plastic Pipe

A new composite plastic pipe announced by Sievers Company combines 2 types of plastic tubing to obtain special properties required for down-hole operations. The pipe, designed for bottom-hole uses such as well liners and casing windows, uses a polyvinyl chloride extruded tube for its internal surface. The exterior of the tube is wrapped with helically interwoven, continuous filaments of fiber glass, impregnated with epoxy resins and heat cured. The resultant pipe rivals steel in strength, resists chemical and electrolytic corrosion. Liners are made in 20-ft lengths and joined by molded threads. *Sievers Company.*

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Pressure Control for Hazardous Locations

A new pressure control for use in hazardous locations has been developed by Mercoid. Designed for minimum weight and space requirements, the control features external adjustments for range set-

tings, visible calibrated dial, visible mercury switch, ½-in. external and ¼-in. internal connection. Available in 21 operating ranges from 30 in. vacuum to 1000 psi. *The Mercoid Corporation.*

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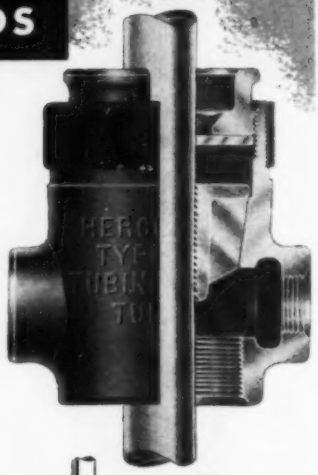
The dual purpose "Type J-5-S" Stripper Tubing Head is basically a "Type J-5" Tubing Head with a bowl (top section) screwed into the packing nut thread. The hinged slips, packing and packing nut are installed in the bowl (top section) with the tubing stripper in the body (lower section), thus permitting tubing to be run-in or removed under pressure. Test pressure is the same as the "Type J-5" Tubing Head.



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Improved Rubber Guide Cage

An improvement in the Martin rubber guide cage, which provides complete protection for the cage in situations where extreme or unusual ball impact might occur, has been announced by the manufacturer. Protection is accomplished in all open type cages by leaving a cross bar of the cage metal above the ball to serve as a back-stop for the resilient ball stop. The same protection is provided in the closed type cages, when needed, by optional ball guides having metal inserts in their upper portion. *John N. Martin, Manufacturer.*

Circle number (5) on reply card.

Hydraulic Jack Line Expanded

Two new "high lift" hydraulic jacks have been added to their Simplex line by Templeton, Kenly & Company. Both have a capacity rating of 25 tons and are equipped with both high and low speed pumps. One model has a closed height of 28 in. with a 22-in. lift, and the other has a closed height of 22 in. with a 16-in. lift. Both models are designed to lift 50 percent over their 25-ton rated capacity. *Templeton, Kenly & Company.*

Circle number (6) on reply card.

Gage Hole Cover with Flexible Seal

Shand and Jurs has offered a new gage hole cover which eliminates spherical machining on seat and cover. The base seat, faced with stainless steel, has a flexible, leak-proof safety seal ring that prevents vapor loss and minimizes corrosion. The handle has been designed to

open quickly either by hand or foot. The unit also contains a tape gage marker point and a thermometer hook. The base is flanged steel, supplied plain for welding or drilled to match 150 lb drilling. *Shand and Jurs Company.*

Circle number (7) on reply card.

Continuous Level Gage

Radiation Counter Laboratories has introduced a continuous level gage which measures the level of liquids in totally enclosed containers of any size and dimensions with accuracy to a few hundredths of an inch. A small radioactive source contained in a float follows the level of liquid along a path predetermined by guide lines placed inside the tank. Radiation emitted by the source is detected by a scintillation detector located outside the tank. Changes in the level of the liquid cause changes in the strength of radioactivity detected. This change is then calibrated in linear distance or volume. *Radiation Counter Laboratories, Inc.*

Circle number (8) on reply card.

Underwater Headset For Offshore Operations

An underwater headset, originally built to U. S. Navy specifications, has been made available for offshore exploration and drilling operations. The unit is non-corrosive and is sealed for underwater operation in salt or fresh water to depths of 100 ft. The unit withstands wide temperature ranges and is highly shock resistant. It is available with magnetic shielding. *Telex, Inc.*

Circle number (9) on reply card.

Burglar-Proof File Protects Valuable Maps

A new fireproof and burglar-proof file is offered by the Charles Bruning Company. Valuable drawings and maps can be protected from fire and theft without a vault or large safe. Drawings as large as 31 in. by 42 in. can be protected in the unit. The file is equipped with a key lock and a drill-proof steel plate located ahead of all locking mechanism. It is also available with a combination lock. *Charles Bruning Company, Inc.*

Circle number (10) on reply card.

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CLUTCHES

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Drilling-Producing Literature

Chemical Services Bulletin

A comprehensive bulletin published by BJ Service reviews each acid treating solution, chemical blocking agent, and auxiliary chemical service offered by BJ for well stimulation. The bulletin includes a discussion of the composition, purpose, and action of each chemical formulation, together with charts and a glossary of terms used in chemical well-stimulation work. *BJ Service, Inc.*

Circle number (11) on reply card.

Plant Layout Models

Scott Industries has published a catalog introducing a series of assemble-it-yourself machine tool kits for plant layout in 3 dimensions. The kits include planning mills, lathes, milling machines, drilling and sawing machines, sheet-metal machines, office equipment, etc. In addition, the company offers thousands of extra parts such as pipe, fittings, motors, etc., for completion of the model layouts. *Scott Industries, Inc.*

Circle number (12) on reply card.

Blowout Preventer Catalog

A 20-page catalog has been made available by Stewart & Stevenson featuring Koomey blowout preventer operating and testing units. The catalog, complete with illustrations, photographs, diagrams, charts, and equations, contains information for specifications for fluid manifolds, power source, remote controls, and other data. Formulas and examples for selecting proper BOP operating units are given. *Stewart & Stevenson Distributing Company.*

Circle number (13) on reply card.

Air and Gas Drilling Brochure

A brochure prepared by Well Completions outlines safety precautions and recommendations used in air and gas drilling of oil wells. The brochure presents discussions dealing with compressor location and accessory equipment, rig location and equipment, steps prior to drilling, and drilling operations. *Well Completions, Inc.*

Circle number (14) on reply card.

Weed and Grass Killer

Ureabor, a weed killer which gives full season control of unwanted vegetation, is described in a new bulletin. The compound is a combination of borates and substituted urea ready to apply in its dry, granular form. The chemical is non-selective and can retard growth of plants for a year or longer. *United States Borax & Chemical Corporation.*

Circle number (15) on reply card.

1958 Equipment Catalog

Cardwell's servicing hoists, drawworks, masts, and mud pump equipment are described in a new 60-page catalog. All equipment is illustrated, and detailed charts on line speeds and pulls, drum capacities, performance, and dimensions are included. Cardwell's new V-series mud pumps are described in detail. *Cardwell Manufacturing Company.*

Circle number (16) on reply card.

Spark Resistant Gaging Tape

A new gaging tape made of spark-resistant materials throughout is described in a brochure presented by Lufkin Rule. The tape has a special analysis stainless steel line with a durable chrome-clad finish. A long handle with a large drum gives maximum winding leverage. The line can be locked at any desired point. *The Lufkin Rule Company.*

Circle number (17) on reply card.

Lubricated Pump Plunger Brochure

The Oilmaster oil-lubricated plunger is described in a new 4-page bulletin. It covers operational details, general description, specifications, and cataloged parts information. *Fluid Packed Pump Company.*

Circle number (18) on reply card.

Water Meter Rate Recorder

The use of rate recorders for water meters is outlined in a brochure offered by F. S. Brainard. Instruments are connected in direct contact with the meter without disturbing the meter's operation. Both single-pen and dual-pen models are described in the literature. *F. S. Brainard & Company.*

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Entirely New!

GAS-OIL RATIO KITS

The Merla Gas-Oil Ratio (GOR) kits, compactly assembled in a sturdy metal case, contain all the equipment required to take gas-oil ratio tests.

The equipment consists of a pressure recorder, complete with clock, recorder charts, ink, winding key, orifice capacity tables, 2" Merla Quick Change orifice well tester with seven orifice plates and 10' of ¼" hose with snap-on fittings. The kits are available with single or two-pen recorders in a variety of pressure ranges to cover all standard requirements.

The sturdily constructed steel case protects the equipment during storage, transportation, and use. The presence of all required equipment is easily checked by visual inspection.

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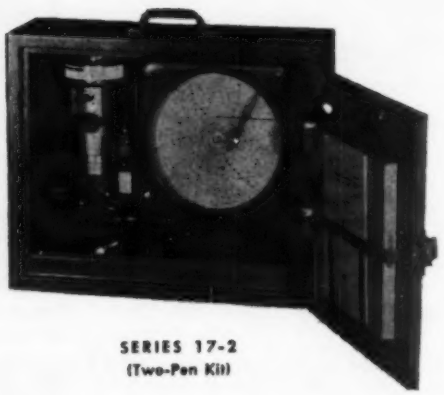

SERIES 17-2
(Two-Pen Kit)

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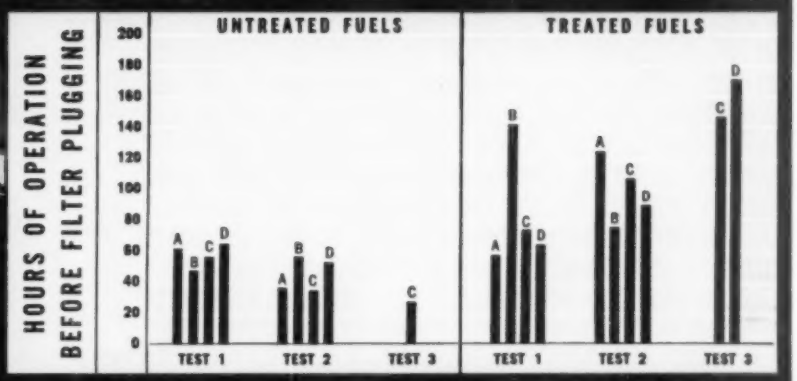
the Refining Engineer

Refining Petrochemical Gas Processing



A, B, C and D represent different diesel earth-moving vehicles used in the tests

Additives double the life of diesel fuel filters in earth-moving equipment, cut downtime in half

Five recent months of field and laboratory tests put new light on filter performance in automotive diesel equipment.

The first field testing phase determined the "hours to plugging" of secondary filters in earth-movers operating on fuel which had *not* been treated with Du Pont additives. These were the commonly used resin-impregnated paper filters with a porosity of approximately two microns . . . filters known to afford excellent protection for the fuel-injection units.

In the second phase, Du Pont Fuel Oil Additive No. 2 (FOA-2) and Du Pont Metal Deactivator (DMD) were added to the test fuel. *Filter life,* on the average, *was doubled.*

This means, of course, that only half as many filters were required, and that costly downtime for emergency servicing in the field, and filter replacement, was cut in half.

Insoluble residue reduced

FOA-2/DMD combinations reduce the amount of insoluble residue which normally forms in a fuel during storage or recirculation in an engine fuel system. FOA-2 acts also as a solubilizer and dispersant of sludge formations, and will prevent injector sticking and filter fouling. DMD retards the formation of copper mercaptide gel as well as combatting the adverse catalytic effect of copper-bearing metals in a system.

More flexible processing

By using FOA-2, you can balance stocks to meet varying market demands, because it stabilizes fuel during storage. You can stabilize cat-cracked distillates or blends with straight-run stocks. And, you can improve residuals, too.

Test your own stocks

It's easy to test FOA-2 and DMD in your own stocks.

Samples and technical information are available from your Du Pont Petroleum Chemicals Division technical representative. Contact him for further details.

E. I. DU PONT DE NEMOURS & CO. (INC.), Petroleum Chemicals Division, Wilmington 98, Delaware.

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and other
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and others interested

in the problems growing out of

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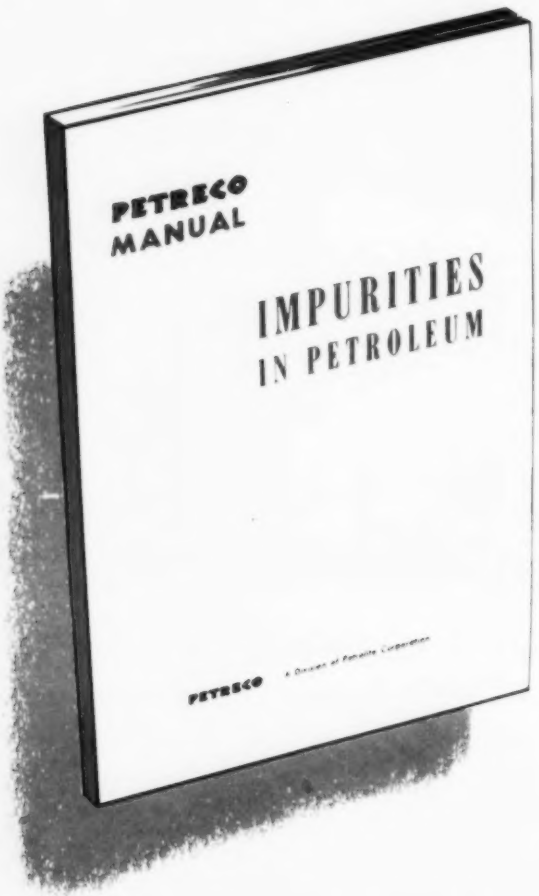

THIS TECHNICAL MANUAL is an up-to-date summary of impurities commonly found in petroleum and its products, especially as related to their significance in refinery operations. It contains the results of Petreco's extensive research on the subject, as well as the latest contributions from others in the industry. Part I describes how these impurities are affecting refinery operations where new processes, especially of the catalytic variety, have in recent times tended to disproportionately increase their harmful effects. The growing demands to produce maximum yields and premium products make this topic an increasingly important one. Part II presents a series of selected and tested analytical methods applicable to the evaluation of processes designed for the removal of these impurities.

Here are just some of the topics discussed in this informative new edition:

PARTIAL TABLE OF CONTENTS

THE NATURE OF PETROLEUM IMPURITIES • *Oleophobic impurities* • *Oleophilic impurities* • *Impurity residues from chemical treatments.*

SELECTED ANALYTICAL METHODS • *Sampling* • *Water Contents of Oils* • *Carry-over from Chemical Treatments* • *Salts in Crude Oils* • *Direct Determination of Chlorides* • *Phenols, Thiophenols, Mercaptans, Sodium and Free Sulfur in Distillates* • *Fouling Test for Settled Alkylates* • *Water Reaction Test for Aviation Fuels, etc., etc.*

THIS INFORMATIVE MANUAL IS YOURS ON REQUEST—For your personal copy of the newly-revised "Impurities in Petroleum", address your request to Petreco on your company letterhead, including your name and title.

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PM-58-1

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Vickers' new multi-million dollar petrochemical complex built by Procon, Incorporated, is the first petrochemical plant to be built in Kansas, and is expected to produce more than 15 million gallons of petroleum aromatics annually.

Throughout the world, operators have proved that Koch's economical fractionating trays have as much as 25% better efficiency than conventional bell cap trays... give higher capacities, lower pressure drop, and reduce maintenance costs. Over 800 installations have proved the Koch Flexitray's superiority over other devices in capacity, flexibility, and efficiency! KOCH FLEXITRAY—COPIED BY OTHERS—MATCHED BY NONE!

In planning your next tower, consult KOCH!

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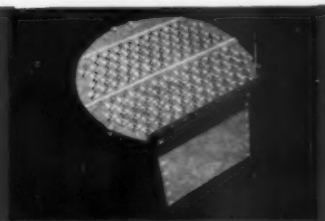

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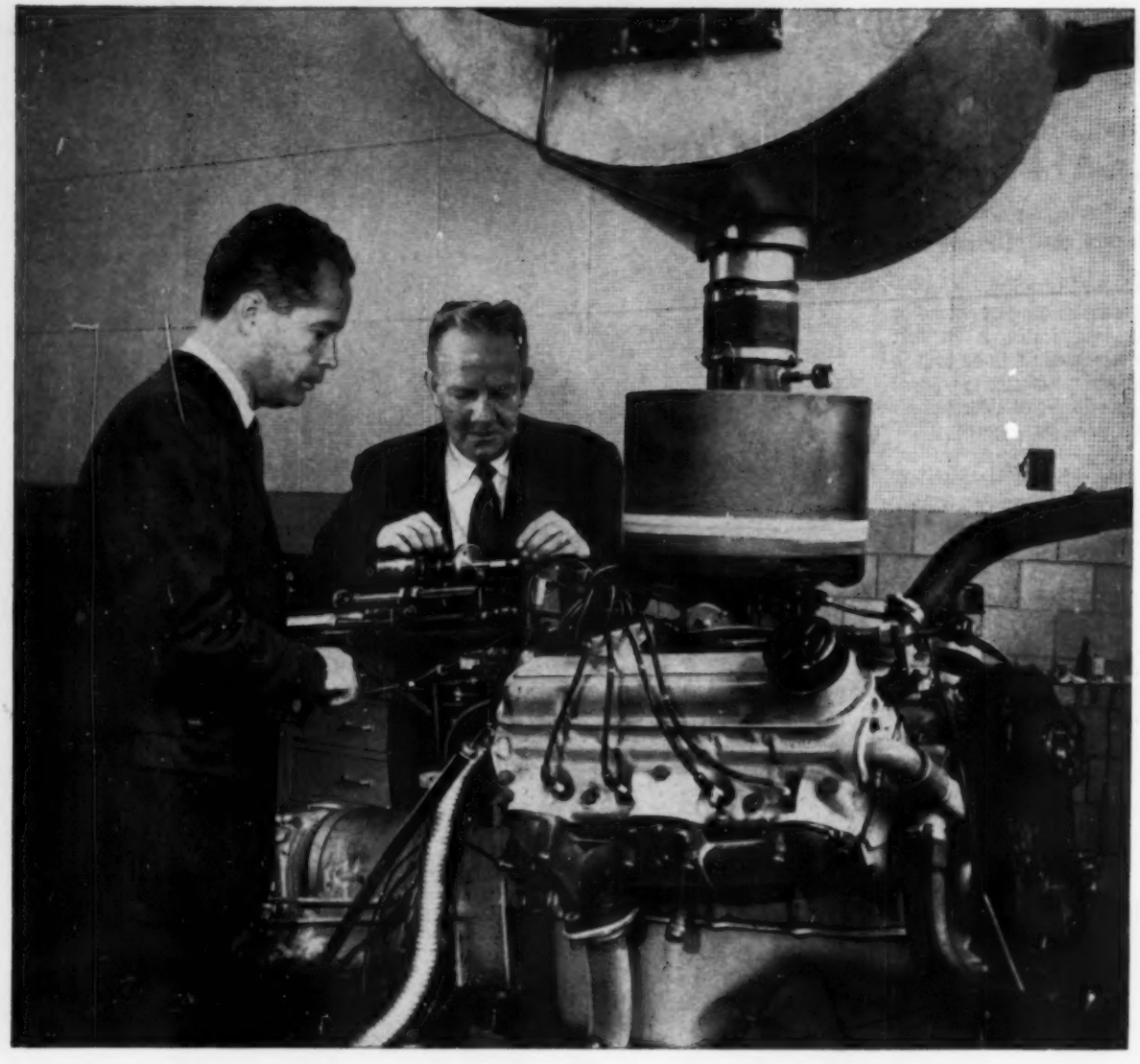

Ethyl Research helps you match gasolines to 1959 cars

By C. B. Kass and H. A. Toulmin, Ethyl Corporation Research Laboratories

ONCE AGAIN—for the fourth consecutive year—Ethyl Research Laboratories in Detroit have carefully estimated the octane requirements of 1959 U. S. automobile engines for the benefit of the Oil Industry.

Octane requirements of U. S. automobile engines have been compiled and expressed by graphs.

Separate curves have been plotted for trace knock—that point at which engine knock first becomes recognizable to the experienced technician; and light knock—the upper limit tolerated by the average driver.

Graphs show octane requirement range

A separate bulletin has been issued for each engine model included in the study. Data were made available to oil companies at the time of the introduction of the new-model cars.

Distribution curves in each bulletin show the percentage of 1959 automobiles satisfied at each point in the Research octane number range of today's commercial gasolines.

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Predictions based on 35 years of experience

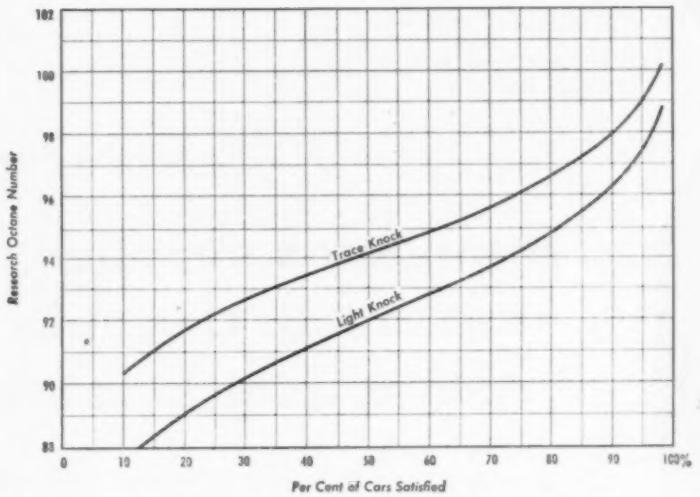
Ethyl engineers depended upon three factors in their study of 1959 engine octane needs:

1. Known octane requirements of predecessor engine models (established by Ethyl studies and studies made by the Petroleum and Automotive Industries).

2. Engine specifications for the 1959 models, supplied by the manufacturers.

3. Knowledge of the effect of engine design changes on octane requirement established by 35 years of study.

These predictions—made with considerable accuracy over the years—have proved helpful to oil companies in tailoring their fuels to satisfy the engine octane requirements of the new-car population.



Typical prediction of octane number requirement.

How Ethyl Research is helping you

The study described here is an example of Ethyl's continuous service to refiners by keeping them informed of the latest developments that affect the fuel-engine relationship.

Additional information on the fuel needs of past and present automobile engines can be found in the booklet "Octane Requirements of Past and Present U. S. Automobiles 1957 Supplement."

Copies of this booklet are available from your Ethyl Representative, or by writing Ethyl Corporation, 100 Park Ave., New York 17, N. Y.

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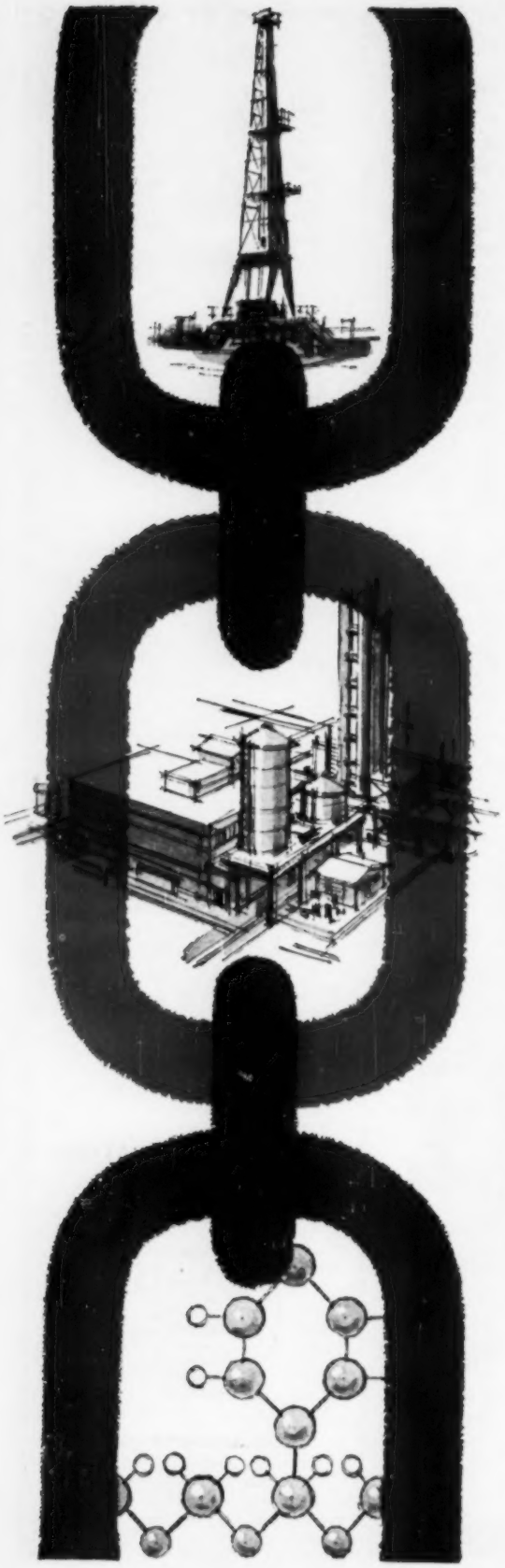

Blaw-Knox supplies vital link in Cosden's crude-to-plastic chain

From crude oil to ethylbenzene to styrene and finally polystyrene—with this pace setting program, Cosden Petroleum Corporation makes oil industry history. In designing and building Cosden's polystyrene plant, Blaw-Knox proudly joins this enterprising company in the vanguard of petrochemical activity.

A unique combination of know-how in resin manufacturing, chemical production and petroleum refining has made Blaw-Knox a leading contractor for industry's most progressive projects.

Perhaps this background of over 90 plastic and resins facilities can be helpful to you. Contact our engineering staff for a conference. Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, New Jersey, Birmingham, Washington, D.C. and San Francisco.

for plants of distinction . . .

BLAW-KNOX

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A true preventive approach is envisaged here . . .

A Concept of Maintenance

This academic approach to solution of maintenance problems . . . both operating and organization-wise . . . offers to top management methods for effective control and minimum costs in today's plants and the automata of tomorrow

Joseph B. Smith, Jr., *Chevy Chase, Maryland*

IN THIS PERIOD OF REDUCED PROFITS, direct and indirect costs of equipment failures occupy an increasingly critical relationship to total operating costs. Maintenance must therefore be examined in the overall scheme of company operations, and sound administrative principles applied to systemize the maintenance function.

A concept of maintenance believed particularly applicable to modern and future industry is discussed here. The approach is academic. It theorizes about a practical subject. A complete exposition is not attempted. It is intended to be thought provoking. It will be of greatest interest to engineering staff people on the management level.

The Concept . . . A Preventive Approach

This concept envisages a true preventive approach to solving maintenance problems.

It is based on the premise that materiel failures are caused —that there is a kind of cause and effect relationship between the damaged and the cause of the damage. True causes of failures must be sought in the immediate surroundings and forces of the situation, and in the past conditioning and capabilities of the materiel and of the men who designed, constructed, operate and service it. And causes and effects are interrelated in complex ways that are not easily understood.

The term "maintenance" would be re-defined. It would include ALL activities required to eliminate, lessen the effects of, or neutralize, directly or indirectly, materiel failures and shutdowns caused by these failures. Maintenance would be practiced, therefore, at every echelon from the top, downward through the organization structure, to the lowest layer — the doer.

Activities would be directed at maintaining the "total" operation rather than at servicing individual pieces of equipment. Specific efforts would be concentrated on discovering: (1) Causes of critical failures; (2) Effects of these failures on the accomplishment of the plant or company objective; and (3) Economically feasible corrective measures. Causes, effects and corrective measures would be determined by scientific maintenance research.

The ultimate goal . . . removal of causes. Since research operations are often time-consuming and untimely, certain precautionary procedures would be followed until proper corrective measures could be applied. These would be characterized by scheduled inspection and materiel repair or replacement conducted so as to minimize critical failures and emergency shutdowns and at times favorable to manufacturing operations. Nevertheless, these procedures would be an expedient and as such only an immediate objective. The ultimate goal would remain the permanent removal of causes.

The maintenance organization visualized would fit appropriately in any company structure. It would include staff and line: *Staff* — which plans, organizes, develops key personnel, directs, coordinates and controls; and *line* — which executes.

The maintenance cycle would be the mechanism by which completed maintenance staff action would be accomplished. Line activities would be conventional. Communication on technical matters between echelons would be conducted through maintenance channels.

Finally, maintenance would be integrated into the overall scheme of company and plant operations. Top management decisions in either case would reflect an estimate of the capabilities of materiel failures and emergency shutdowns to affect the accomplishment of the company or plant objective. Maintenance would be as much a function of top management as personnel, production, manufacturing, marketing and finance.

Cornerstone of the Maintenance Concept

This concept stems from an interpretation of the historical development of maintenance. Three observations are its corner stone:

- As technology advanced, maintenance grew more important in the hierarchy of administrative and operational functions.
- The greater the rate of technological change, the more attention was given as to the exact location of maintenance in the organization structure.
- Proper maintenance support always trailed considerably technological development.

When considered in terms of present technology and that

© 1958, by Joseph B. Smith, Jr.

Cause and effect relationships are frequently misunderstood.

indicated for the future, these observations clearly indicate that:

- The maintenance function must be raised in the organization structure.
- The move must be bold.
- The relocation must be done now.

Present Situation . . . Far from Satisfactory

In spite of progress made in recent years, the overall maintenance situation remains far from satisfactory. Serious differences of opinion as to what constitutes the proper approach to maintenance persist. Plant practices vary widely. The state of present-day maintenance is implicit in the lack of agreement throughout industries as to just what "maintenance" really means or includes. Yet *now* is the time when understanding and order are needed most.

Industries today are standing at the threshold of a new revolution, one far more critical than the Industrial Revolution. In the future, they will grow larger and more complex —equipment more sophisticated and specialized. An increasing number of systems will be geared to operate at preselected (optimum) rates. Yet, unless maintenance is vastly improved, complete units and entire processes will be slowed or shut down by no more than the failure of one small element.

A Maintenance Philosophy for Top Management

As technology advances, many machines and systems of machines will tend to acquire the characteristics of human beings. If the complexity of machines, the variable, approaches the complexity of man as a limit, and there is ample evidence it is doing so, then philosophies affecting the "maintenance" of man will apply equally well to the maintenance of automata. Thus, disciplines concerned primarily with problems of man can provide seriously needed guidance for developing sound maintenance philosophy for automatic systems.

The conception of damage to or failure of materiel implies a connection or causal relationship between the materiel and the cause(s) of the damage or failure. That is, there is a kind of cause and effect relationship between the damaged and the cause of damage.

No two items of experience ever stand in complete consonance as to cause and effect. This fact is frequently ignored, often leading to the acceptance of that which is not necessarily true. Reference is consistently made to oversimplified cause and effect relationships as if the surroundings and related factors had no bearing on the case.

This is an expediency, and as such is useful and worthwhile. It has been a major factor in much of our past maintenance doctrine. The fact remains, however, that every cause has an uncertain number of effects, and every effect has roots in an equally uncertain number of causes. Thus, causes and effects are inter-related in complex ways that are not fully understood. And, since practical problems are often solved by ignoring all variables but the ones which are most familiar, interpretations are always subject to error. Sometimes the error is unimportant, and little is lost by the use of the expedient method; but there are situations in which the errors introduced by over-simplifications are sufficient to produce costly or even tragic failures.

How materiel failures are controlled. As described, this maintenance concept is based on the premise that failures are *caused*. Control of failures would be provided in two ways:

- By creating an awareness of the importance of *maintenance prophylaxis* throughout the organization structure, and
- By using *maintenance-therapy*, both terms coined solely for use in describing this concept.

Maintenance prophylaxis refers to the employment of precautionary measures and methods to reduce or prevent untimely materiel failures. It is characterized by some kind of scheduled inspection and repair or replacement of plant materiel conducted so as: (1) To prevent or reduce such failures and (2) to carry on maintenance work at times and in proportions favorable to production operations.

Maintenance-therapy applies to the elimination of causes of materiel failures through corrective measures determined by scientific maintenance research. Economically feasible corrective measures are based on the cause(s) of the failure and the effects of this failure on the plant or company objective. This is in contrast to the administrative-type activi-

Check List for Key Factors in an Effective Maintenance Program

In spite of differences of opinion on what is the proper approach, many maintenance experts (line) agree, wholly or in part, that the following are significant aspects of an effective maintenance program:

- Maintenance receives full support of top management.
- Importance of maintenance is recognized by all personnel.
- Maintenance policies reflect overall plant policies.
- Maintenance organization fits appropriately into the plant organization.
- Maintenance objectives are clearly defined.
- A combined breakdown and scheduled maintenance scheme is followed.
- Maintenance is planned, with needs properly gaged.
- Maintenance performance is accurately measured.
- Specific jobs are scheduled.
- Cost control is used.
- Inspection is based on selected criteria.
- Accurate and complete records are kept.
- Spare parts are controlled.
- A lubricating schedule is followed.
- Tabulating machines are used where economically feasible.
- Competent maintenance personnel are used in adequate numbers, whether company employees or on contract.

ties generally stressed throughout industry at the present time. Although the removal of *symptoms* of materiel failures is an immediate objective, the ultimate goal of maintenance-therapy is the permanent removal of causes. This objective requires the use of a variety of professional services.

This concept is believed unique in that its primary objective is the removal of causes of failure before the failure occurs. Just as it is essential to recognize and remove the cause(s) which drives a person to suicide, so it is fundamental to do the same for causes of materiel failures. In both cases, the corrective action, to be fully effective, must be taken before the "failure" occurs.

Also implied in this philosophy is a distinctive and significant model of maintenance structure. Although the description seems to limit its use to complex machines and systems, it will apply equally well to all materiel from the most complicated to the simplest, but only as long as the model remains unchanged.

Some will question this machine-man analogy. If so, they are referred to the science of Cybernetics, the science of control and communication in the animal and machine.

Finally, two hypotheses based on this philosophy can be stated:

- **Maintenance applies to the total operation.**
- **Maintenance concentrates on determining causes of failures, effects, and preventive or corrective measures.**

The Organization Structure and its Functions

How is this maintenance function fitted into an organization structure and how is it related to other management functions?

Because there is so little agreement throughout industry on structure, no attempt is made to answer this question in terms of any existing or practical organization structure. Instead, one created in a thought-experiment will be used.

Think of a manufacturing corporation in a legal sense — as a person.

He has a specific objective to accomplish. He is responsible for every thing he does or does not do while accomplishing his lawful purpose. His tasks are countless. He plans, organizes, develops key personnel, directs, coordinates and controls, or stated another way — he administers, so that he can efficiently execute, or operate.

Administrative tasks may be separated into four functional areas. Activities in each area relate to:

Area 1: Personnel as individuals (employment, recruiting, salary, retirement, safety, morale, medical, etc.).

Area 2: Personnel as groups (organization structure; operating, service and specialty units; operations by these units; materiel for operations; training; etc.).

Area 3: Logistical support (engineering, construction, utilities, supply, transportation, repairs, storage, salvage, etc.).

Area 4: Matters not necessarily under his direct control (environment — terrain, weather, cultural factors, etc.; sources and composition of raw materials; technological capabilities; demand, price, acts of God, etc.).

He chooses not to accomplish all these tasks alone. He uses assistants. Some coordinate primarily; others advise in special fields; while a third group serves in a dual capacity by advising and executing. A coordinating assistant supervises each functional area. These assistants are his *staff*. He, supported by his staff, is Top Management.

Neither does he personally choose to execute. He accomplishes this by means of operating or manufacturing plants. He assigns a manager with an objective to each plant to accomplish this task for him; however, he relinquishes none of his responsibility in doing so. They are responsible to him. Each manager is also assisted by a staff. Operating units produce — service and special units support operations.

Maintenance..a Top Management function...requires line and staff.

The plants are his *line* — the doers.

Thus, as a total entity, he is primarily concerned with: Administering and executing. This is the outline of his or any organization structure.

Now, examine his administrative tasks more closely.

He can control directly all activities in Areas 1, 2, and 3. He can add to, delete from, or modify these tasks as he chooses.

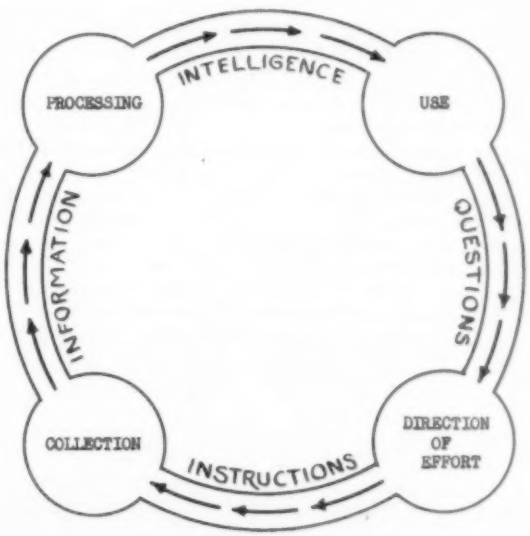
On the other hand, he has little or no direct control over certain matters in Area 4. This is particularly significant since they are as important to him in accomplishing his objective as tasks in the other areas, and sometimes more so.

Furthermore, these factors are complicated by the fact they require investigative treatment before they can be integrated into the overall scheme of company operations. Research is the required mechanism. Physical and social sciences are the tools. Economically feasible conclusions are the goals.

All his decisions reflect the capabilities of these factors to affect the accomplishment of the company objective.

How does maintenance fit into this? In the strictest sense, materiel failures and matters relating to emergency shutdowns are not under his direct control. Regardless of how insignificant, they always interfere with his reaching his goal. Also, they may be extremely costly in dollars and in life. Their scope and nature require that they be included and considered equally with other Area 4 matters in administering the company's operations.

Maintenance thus includes all activities he conducts to eliminate, lessen the effects of, or neutralize, directly or indirectly, materiel failures and shutdowns caused by such failures. Maintenance, like activities in the other areas,



The Maintenance Cycle.

Proper organization facilitates maintaining the "total" operation.

extends from the top echelon, downward through the organization structure to the doers. Doctrine remains unchanged — only scope and depth of application decrease. Direct communication on technical matters is provided through a maintenance channel.

This thought-experiment supports two more hypotheses:

- **Maintenance organization includes staff and line: Staff—which plans, organizes, develops key personnel, directs, coordinates and controls; and line—which executes.**
- **Maintenance is a top management function.**

The latter conclusion is consistent with the cornerstone presented earlier — the maintenance function should be raised boldly in the organization structure—now.

The Maintenance Cycle

Maintenance staff action is an unusual element of the concept. Line activities are conventional. For example, a maintenance line unit would be a conventional plant mechanical department with all its craft representation.

The Maintenance Cycle is the mechanism by which completed maintenance staff action is accomplished. It is an orderly procedure divided into four steps:

- Collecting maintenance information.
- Processing maintenance information into intelligence.
- Using the resultant intelligence.
- Directing the collection effort.

Note: Information is raw substance. Intelligence is a finished product. Maintenance intelligence, hereafter referred to as Intelligence, is processed maintenance information.

These steps are concurrent. At the same time maintenance information is being *collected*, other information is being *processed* into Intelligence, and Intelligence is being *used*. The entire operation is constantly *directed*.

These four steps are the lowest common denominator or the operational cycle of maintenance. Each is indispensable. If one step fails, the entire operation fails also.

COLLECTION: This is the systematic collection of maintenance information by collecting agencies. It includes delivery of that information to those assigned to process it.

A collecting agency is a person, a group of persons, or an instrumentality that acquires information by research, personal observation, or interview. Examples are research laboratories, trade associations, professional societies, plant inspectors, mechanics, equipment specialists, and operators. In the final analysis, all personnel coming in contact with materiel are potential collectors of information.

PROCESSING: Processing is the means by which maintenance information is converted into Intelligence. It includes three basic operations: (1) Recording, (2) Evaluation, and (3) Interpretation.

Recording consists of sorting, grouping, and filing raw information to facilitate study and comparison.

Evaluation is the appraisal of an item of information to determine its pertinence (relevance and possible value), the credibility of the source (reliability, training, and experience), and its accuracy.

Interpretation analyzes critically the evaluated information to determine significance with respect to other information or Intelligence on hand.

Proper processing produces Intelligence that is concise, free from irrelevant matter and ready for use. Such Intelligence will convey not only facts but also the significance of those facts together with all the deductions drawn from their study in the light of other Intelligence already on hand.

USE: The ultimate use of Intelligence is to determine economically feasible corrective measures that will affect materiel failures. The top executives at company or plant level also use it in making sound and timely decisions. Many others in the company and in other enterprises find it of considerable value. At plant level, Intelligence is of particular value in activities such as maintenance planning and scheduling, spare parts control, proportioning the plant maintenance organization, and cost control.

The basic activity in this step is integrating Intelligence into an up-to-date estimate of the maintenance situation in the company or plant. This estimate summarizes significant aspects of plant materiel, environment, and factors and their capabilities to cause materiel failures and affect total operations. It analyzes these capabilities with respect to one another and considers each in relation to the company's or plant's objective. Conclusions are often expressed in dollars for budgetary control and for purposes of comparison.

The doctrine of capabilities is important because it is objective and based on facts. Intentions are seldom considered. Capabilities must answer these questions in regard to each factor causing a materiel failure: *Who* or *What? Where? When? How?* and *Why?* The following illustrates this point:

What? Hydrogen sulfide corrosion.

Where? Carbon steel radiant section furnace tubes Nos. 1 - 30, Pipe Still No. 1.

When? Between 500 F and 900 F.

How? Reaction with steel causing deep, rather characteristic pitting.

Why? Hydrogen sulfide corrosion is a secondary reaction in which iron sulfide sets up a galvanic cell with steel as a sacrificial anode.

Intelligence to be useful must be made available to all who need it. It must be furnished in suitable form and in time to serve their purposes. The form required by a top executive will not necessarily be appropriate for other echelons or offices.

Means for distributing Intelligence include: Special estimates and reports, periodic reports, summaries, conferences, committees, letters, memos, and messages.

DIRECTION: Direction of the collection effort is the last step. Plans for collecting maintenance information must be constantly revised. Intelligence already on hand will require new instructions or requests for new types of information. Direction of the collection effort is continuous.

Direction consists of four successive operations:

1. Determination of *questions* to be answered.
2. Determination of *indications*.
3. Preparation of a *collection* plan.
4. Issuance of *instructions* to collecting agencies.

Questions relate to specific information of actual or potential factors which may cause materiel failures. Answers to these questions comprise maintenance information.

Indications are evidence, either positive or negative, that may point to or away from a particular cause of failure. The absence of a positive indication in one direction may tend to strengthen another in a different direction. The selection of indications is based on the maxim that, "coming events cast their shadows." Indications are useful in pre-

paring instructions and requests for information.

The collection plan is a device used to prevent omissions or conflicts in requests for information or in instructions sent to collection agencies. It reflects the orderly process of considering each fundamental factor (question to be asked), indications, instructions and requests, and the time and place at which the information is to be reported. It is solely a work sheet.

Instructions and requests for information are the end product of the direction effort.

The receipt of the specific instructions and requests by the collecting agencies returns us to *Collection*, the first step in the maintenance cycle.

Advantages and Disadvantages

Until this concept can be put into practice and tested, its advantages and disadvantages must be deduced. The following are believed to be the more noteworthy.

ADVANTAGES: Its principal advantage would be requiring top executives to accept maintenance as a top management function and to fully integrate it into the overall scheme of company operations.

By separating staff and line, two more benefits are realized. Complex, time-consuming administrative details could be accomplished without interfering with the less complicated, more orderly mechanical line activities. Conversely, maintenance line organizations could be modified to satisfy any type of plant or maintenance situation without affecting staff operations. The latter capability would be particularly useful in multi-plant companies where plants manufacture different products.

Maintaining the "total" operation would be facilitated.

Company-wide standardization programs directed at reducing maintenance costs would be more easily supervised.

In multi-plant enterprises, centralizing the primary staff effort at company level would avoid duplicating many similar activities at the operating plants. Plant maintenance staffs could be reduced. Intelligence, corrective measures and scientific support could be furnished through technical channels.

By reducing or eliminating materiel failures causing explosions and fires, for example, a healthier relationship could be maintained with the communities in or near which plants would be located.

Finally, this maintenance structure would provide a strong effective mechanism for combatting enemy action against industries in time of war.

DISADVANTAGES: The most obvious disadvantage of this concept is its formal approach. A relatively large staff organization would be needed, initially at least. There would be a tendency to operate solely from a chart. Maintenance executives would be prone to become desk-bound because of paperwork. And new human relations problems would arise within the top management group.

A highly specialized staff would be required. Since the scientific method or the operations research approach would often be used, personnel trained in the physical and the social sciences and in engineering would be required. Sound engineering administration would be the outstanding characteristic of the staff.

Good two-way communication with all parts of the organization would be necessary. This would always be difficult to establish and continue.

A company-wide relationship of trust and confidence would be required. If the staff and line are to have confidence in their results, they must be confident they have access to all the necessary information. If top management is to have confidence in the results, it must be able not only to understand them but also to recognize corrective measures as sound and economically feasible. In large organizations, these would be difficult objectives to attain.

About the author . . .

Joseph B. Smith, Jr. *is a key engineering specialist, petroleum, for the Air Force, in Washington, D.C. A civilian, Smith's responsibilities relate to staff consulting, preparation of studies, reports, manuals and regulations for maintenance on permanently installed liquid fuels facilities used by the Air Force, world-wide.*

He has an extensive background in maintenance and operation of petroleum refining and other facilities. After graduation from University of Florida in 1933 (BS in electrical engineering), he spent seven years in various mechanical and operating duties at the Savannah refinery of Mexican Petroleum Corporation of Georgia (now American Oil Company). He served as an Army intelligence officer from 1940 to 1945, then joined the maintenance and construction division of the American Oil Company refinery at Texas City, as an engineer and supervisor.

Smith served the Army as a counter-intelligence officer during the Korean War (1948-1952), then became a civilian employee, engaged in strategic planning of petroleum support by the Corps of Engineers in projected military installations. In 1955, he joined the Department of the Navy to administer construction of petroleum facilities for fuel depots. Present Air Force duties were assumed in early 1957.

George Washington University awarded Joe Smith a Master of Engineering Degree in 1956. In addition, he holds certificates in business administration and building contracting, from International Correspondence Schools.

Mere overt acceptance of the concept would not be enough. Every member of the company, regardless of position or responsibility, must practice its doctrine since every man contributes in some way to "preventing" maintenance. Obtaining such full participation will challenge any administrator.

Finally, it should be noted that most of these disadvantages would apply to any newly adopted program.

Conclusion

Recent scientific break-throughs can easily lead industries into another spiral of technological advances. Full advantage of these developments can not be taken unless steps are taken *now* to protect industries from the rising direct and indirect costs of materiel failures and downtimes. Such failures are veritable monsters to continuous production systems. Maintenance must provide, therefore, not only means for controlling materiel failures but also support for optimizing operations.

Many complex and inter-related factors contribute to materiel failures. Therefore, much more effort must be directed at discovering and treating causes of these failures. Top management must know exactly what effect they have on attaining the company objective. And corrective measures must be economically feasible and not just an expedient. None of this can be accomplished unless the "total" operation is considered.

Scientific facts and principles must replace the rules of thumb and educated guesses now used as basic tools by so many maintenance engineers. Just as cures for the ills of men depend on knowledge gained from medical research, which is then applied by physicians, so corrective measures for materiel failures depend on knowledge stemming from maintenance research, which is then applied by line maintenance engineers.

This concept provides what is believed to be a structure of maintenance fully capable of satisfying the needs of industry, whether they be for the present or for the future.

★ ★ ★

CRYOGENICS

—Key Process and Research Tool

Here are process details, relative operating costs, and applications for low temperature separations of gases — an important, growing area of process technology

J. Ernest Nachod, Jr.
Air Products, Inc.
Allentown, Pennsylvania

"CRYOGENICS" is the science of extremely low temperatures. Long a curiosity, a diverse technology has recently been built around this expanding science.

Cryogenic technology today divides into four principal areas:

1. Gaseous separations. Argon, carbon monoxide, ethylene, fluorine, helium, hydrogen, krypton, methane, neon, nitrogen, oxygen, xenon, and other gases are purified at low cost. Impurity levels are reduced to a very few parts per billion. Valuable fractions are recovered from waste or by-product gas streams, with other stream components simultaneously purified or up-graded. Trace impurities harmful to many vital processes are eliminated completely.

2. Energy storage. High energy gases are liquefied and transported economically. Examples today include ethylene, fluorine, hydrogen, methane, oxygen, oxygen difluoride, and ozone.

Low-temperature control of free radicals promises effective storage and release of energy from cryogenic environments.

3. Sensitive measurements. Practical application has been made of the photoconductive release of electrons by some materials at low temperatures. Infrared radiation from very distant sources may be measured and interpreted for military detection purposes. Operating such equipment in the lowest temperature ranges offers extreme sensitivities.

Recently, superconductivity has made possible the miniaturization of computers by affording a very tiny "on-off" switch of great reliability.

4. Basic Research. Development of fundamental information on the properties of materials in extreme temperature environments brings the observer closer to the properties of various particles in a low-energy state, where specialized, individual characteristics become more apparent.

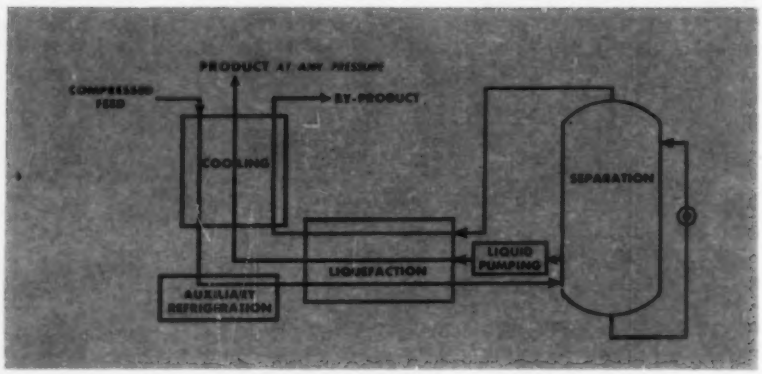


FIG. 1. **Oxygen generation is a four-step process.**

Gaseous Separations

These are the most important cryogenic applications currently of interest in the refining-petrochemical industry.

Best known of these is the classical oxygen-nitrogen separation. The air separation plant is of basic interest in petrochemical operations. Oxygen is important in the manufacture of ethylene oxide by direct catalytic oxidation, the partial oxidation of natural gas or oil to make hydrogen, partial oxidation of natural gas to make acetylene, formaldehyde, ethanol, ketones, methanol, and other oxygenated chemicals. Cities Service is now evaluating oxygen enrichment of catalytic cracker regenerator air (RE for October, 1957, page A-7). Nitrogen is basic in synthetic ammonia, as an inert blanket and purge gas and as a coolant and absorption medium in other low-temperature operations.

Costs and efficiency. Based on relatively simple vapor-liquid equilibria, separation of oxygen and nitrogen from air is a fairly simple process. Manufacture and conservation of refrigeration is a pivotal matter in determining efficiency of any air separation unit. In the most efficient air separation plants, power costs for refrigeration purposes constitute one of the largest single items of total yearly cost. Hence, very large exchanger surfaces are justified in increasing overall plant efficiency.

Because cryogenic processes may involve a 400 deg drop in temperature of a feed material, it is necessary to minimize overall heat load. For oxygen, total cost varies from $6 to $12 per ton, in large plants. Power is about half of total yearly cost, and doubling the outlet and $\triangle$ T from 5 up to 10 F results in substantially increasing power cost. At the larger $\triangle$ T, you are paying dearly to refrigerate the great outdoors.

Separation Processes

Here, following, are comparative descriptions of four typical cryogenic processes used in oxygen manufacture. Comparing their salient features offers a guide to the considerations involved in all cryogenic processing.

Fig. 1 is a schematic of the four-step process requirements for the generation

of oxygen. Water-cooled compressed air is refrigerated in a heat exchange system, liquefied, and distilled.

Distillation. Common to most oxygen cycles is a double distillation column as shown in Fig. 2.

A typical air distillation column is a two-pressure system in which air enters the first, or high-pressure column at about 85 psig. In this "high-pressure" column the air is separated into two portions: (1) Gaseous nitrogen, and (2) liquid bottoms containing substantially all of the oxygen.

Rising nitrogen vapors in the high-pressure column are then liquefied in the condenser-reboiler section (center) and divided into two reflux streams, one for each column.

Liquid bottoms from the high-pressure column, containing all the oxygen, are expanded through a valve to a reduced pressure and fed into the low-pressure column.

Either bubble cap trays or equivalent sieve-type trays are used in the columns, their number dictated by the purity and recovery requirements.

It is interesting that, irrespective of which type of refrigeration cycle may be used, the distillation column is usually the same. Substantially pure nitrogen is withdrawn at the upper level. The liquid is increased in purity from tray to tray until pure oxygen surrounds the reboiler at the intermediate level. (Air is actually a ternary mixture; argon gas off at top, bottom or in side-arm column, as needs dictate.)

Withdrawing gaseous oxygen, the low-pressure column is tapped at a level immediately above the liquid; if liquid oxygen is required, it is drawn directly from the liquid bath.

Many cycles available. All of the various cycles under consideration here are somewhat different, from the fact that you have the choice of withdrawing gas, liquid, or a combination of the two from the column, and this difference is created entirely by the condition of the air coming into the column. For example, in a straight low-pressure plant, this air is essentially saturated vapor. In a full liquid plant, the air feed to the high-pressure column contains liquid with a refrigeration value equal to the liquid withdrawn with the oxygen product, and so on for any intermediate condition of part gas and part liquid.

Low-pressure cycle. Fig. 3 illustrates the low-pressure cycle which is ideally suited for production of oxygen gas in steady-state conditions and in large capacity. The essential features are:

The compressor and after-cooler provide the plant with pressurized air at ambient temperature. Heat exchange is accomplished in two rock or metal-filled regenerators, while the effluent products from the column — nitrogen and oxygen — come out through alternate sets of regenerators. The regenerators, in addition, perform the function of freezing out and eliminating impurities in the air; namely, water at a near-ambient temperature level and carbon dioxide at a lower level.

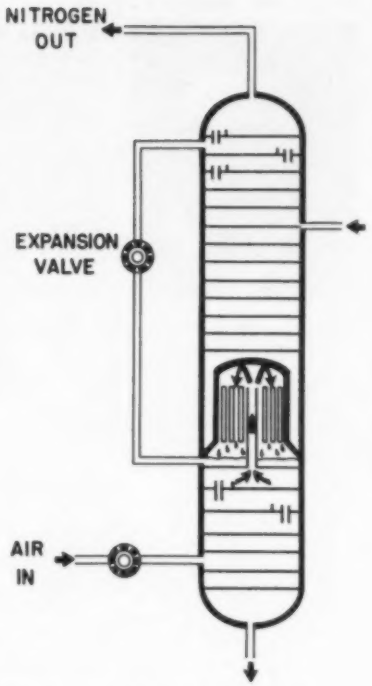


FIG. 2. **This basic column design** is common to all air separation plants.

In the process of warming up, each outgoing product cools the packing in one regenerator while the feed air is being cooled in the alternate regenerator and the feed impurities deposited on the packings. Periodically, the reversing valves switch the direction of flow in all regenerators, the effluent streams go out the alternate regenerators, and the air comes in through the cold regenerator that had been warming up the outgoing products before the switch.

By these means the impurities are removed in the effluent products, and the system is able to go on indefinitely. (Several types of "unbalance" systems may be used to equalize driving forces of vaporization with those of deposition, preventing buildup in regenerators.)

The low-pressure plant requires the minimum refrigeration of any to be discussed, since it takes no liquid from the system. Additional refrigeration, as needed, is supplied by expanding dry nitrogen gas from the high-pressure column in a turbo-expander. Prior to expansion, the nitrogen is partially heated in an exchanger against an air stream split from the regenerators. This protects the expander against formation of erosive liquid in the turbine, adds thermal efficiency, and aids in cleanup of the CO_2 from the air.

This expanded nitrogen is then added to the nitrogen leaving the column, and together they cool the regenerators, maintaining cold in the plant.

It is interesting to note that in plants using this cycle, which are usually quite large, the major refrigeration need comes about from the temperature difference necessary to effectively operate these regenerators. This is the major load. The minor load is that of heat infiltration, since the entire system in the cold box operates from ambient temperature to about 314 F below zero.

Medium-pressure cycle. Fig. 4 shows the medium-pressure cycle. The compressor is usually a reciprocating ma-

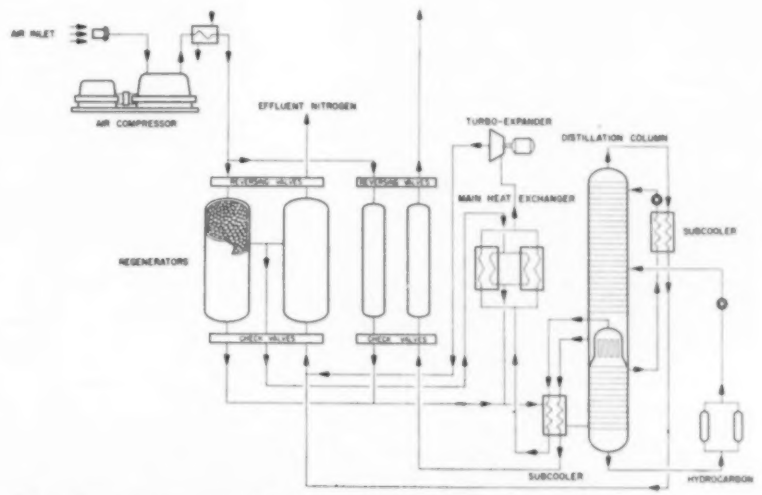


FIG. 3. **Low-pressure cycle.** Operating at 100 psia, oxygen is produced at 2 psig, 95 to 98 percent purity. Centrifugal compressor is used.

chine, since the pressures employed vary from 400 psi upward, depending on the quality and pressure of the oxygen that is produced. Purification of CO_2 is performed interstage.

In this cycle, air is dried in a desiccant-type drier where moisture is removed on one side, while the other side is being regenerated, and they are periodically switched. The air, then under pressure, enters the heat exchanger, and for the most part is then expanded through an expansion valve to the high-pressure column.

A fraction of the air is brought from the heat exchanger through a reciprocating type expansion engine, and it is finally reintroduced into the high-pressure column, at about 85 psi. (In many plants, turbines are used, depending upon requirements.)

The major portion of the refrigeration needed here is supplied by the Joule-Thomson effect across the air expansion valve. However, the expansion engine is employed to save power by making the necessary refrigeration at a lower air pressure.

It is important to note that any maintenance of the expander will not put the cycle out of commission. We can keep the oxygen production intact by simply raising the air pressure to a level which was anticipated in the original design.

Cooling of the air in this case is performed by tubular heat exchangers instead of regenerators, and due to the pressures involved these are ordinarily of the coiled-tube type, with pressurized air and oxygen inside the tubes.

Oxygen is removed from the column as a liquid, and passes into a self-lubricated pump, where the pressure is raised from 150 to 3000 psi, as required. The liquid oxygen, under pressure, is evaporated countercurrent with the incoming air and fed to the process. A stream of liquid may also be withdrawn, if desired, and fed directly into liquid storage, if the reliability requirements are high.

High-pressure cycle. Fig. 5 shows the high-pressure cycle, which has for its object the production of the total output of oxygen as liquid. Liquid is put into storage, and then transported to a missile or other point of use. The cycle has very great similiarity to the medium-pressure cycle in that you also have a reciprocating compressor, the pressures here being of the order of 2500 psi, however.

The clean-up system is the same as for the medium-pressure unit; the drying is the same and the heat exchanger is similar, except the pressures are higher. The expansion engine employed is also a reciprocating type, but designed for 2500 psi pressure with the combination of air from the heat ex-

About the author . . .

J. Ernest Nachod, Jr. *is manager of chemical plant sales for Air Products, Inc., a post he has had since 1956. Receiving a bachelor's degree in chemical engineering from Pennsylvania State University in 1936, he began his career with Du Pont's ammonia department, in pilot plant operations. In 1941, he joined Hercules Powder Company where he rose to the position of technical assistant to the director of research. Nachod served as general manager of the Dure-Tred Company, Chicago, from 1951 to 1956. He's a member of AIChE, ACS, and AAAS, holds patents in maleic anhydride manufacture and HCl recovery.*

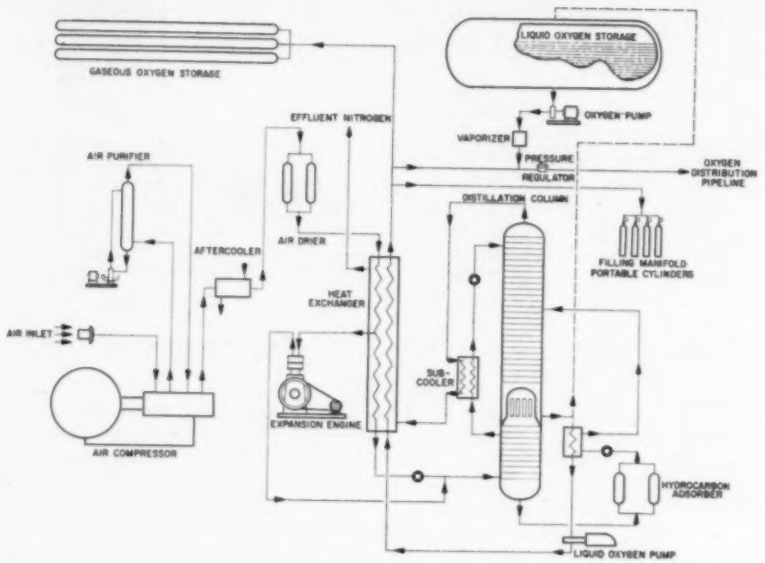


FIG. 4. **Medium-pressure cycle.** Charging 400 to 1000 psia air, oxygen is produced under pressure, plus liquid oxygen sidestream, all at 99.5 percent purity. A reciprocating compressor is required.

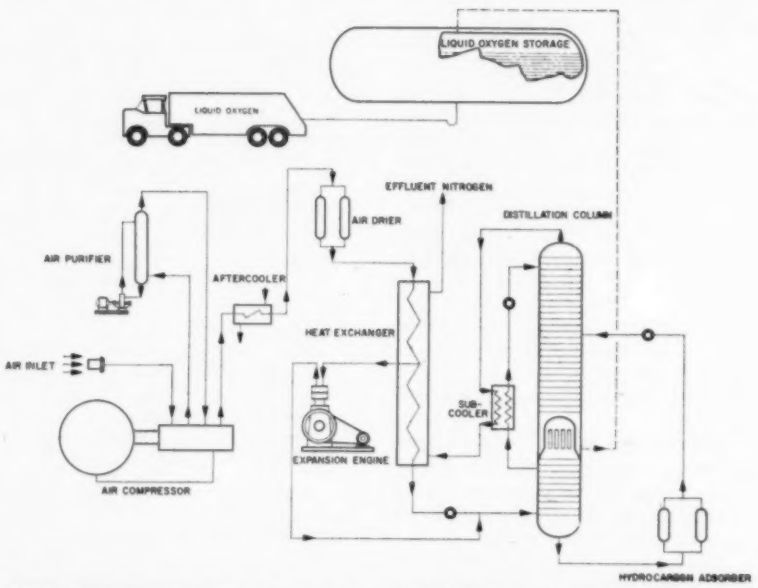


FIG. 5. **High-pressure cycle,** for production of LOX. Charge air is at 2000 to 3000 psia, 99.5 percent LOX is produced at atmospheric pressure.

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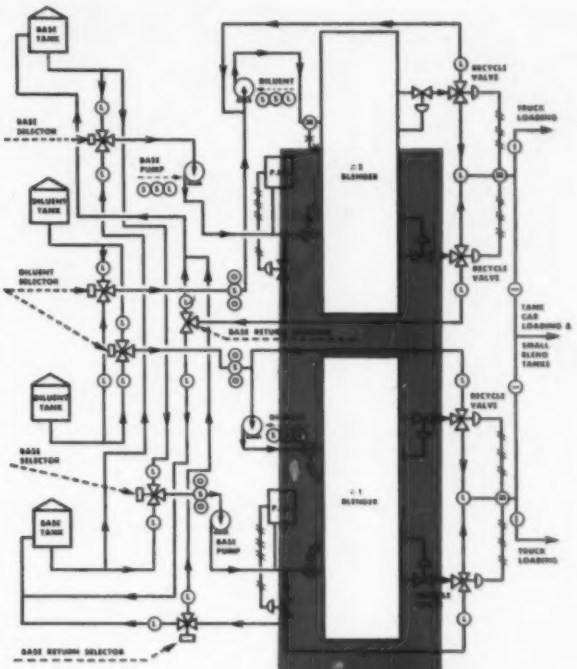

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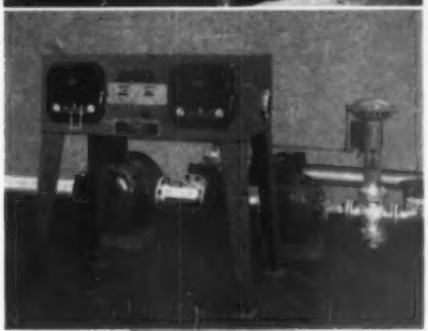

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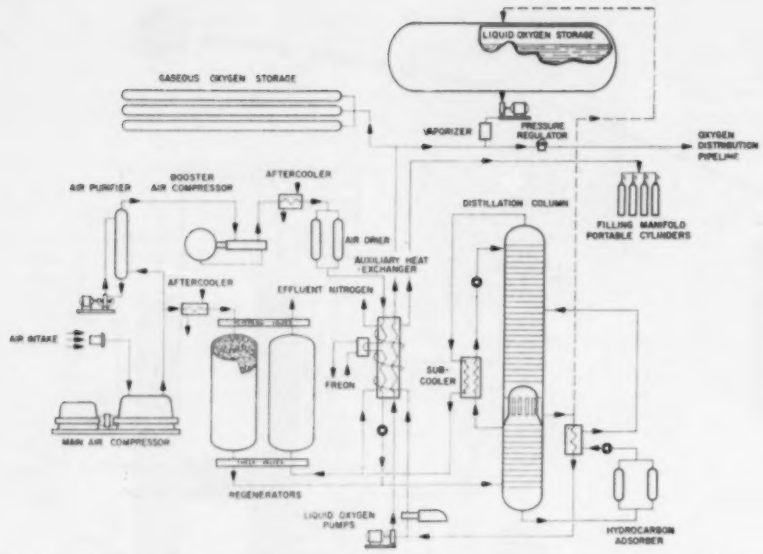


FIG. 6. Mixed-pressure cycle combines high and low-pressure cycles. Oxygen is produced under pressure, plus a liquid sidestream, all at 99.5 percent purity.

changer and the expander air introduced into the column. The refrigeration requirements of this cycle are, of course, much larger since the total production is a liquid; you do not get the benefit of the oxygen cooling the incoming air as in the other cycles.

The expansion engine in this case performs a much more important function. About 50 percent of the total refrigeration is produced by this engine. Therefore, it must be well-designed and well-maintained.

Mixed-pressure cycle. Fig. 6 outlines the new mixed-pressure cycle . . . a combination of high and low-pressure cycles. There is similarity to the low-pressure cycle brought about by the fact that all of the air is first compressed to a pressure of about 85 psi. The difference begins as a portion of the air is chemically cleaned up, compressed to a high pressure in a booster compressor, water-cooled, dried, and separately refrigerated in a heat exchanger; whereas the major portion of air is cooled and regenerated as previously described.

The system shown in Fig. 6 includes a four-fluid head exchanger in which liquid oxygen is vaporized and warmed up at two different pressures. Low-pressure gaseous nitrogen is also warmed. The three cold products give up their refrigeration to cool incoming air. The oxygen from the reciprocating pump may be delivered at 2500 psi, while that from the larger, contrifugal pump may be delivered at virtually any pressure. The system is efficient well below 100 psig.

The other stream of oxygen in this plant is a quantity of liquid which is optional, continuously put into liquid storage. This liquid storage provides a large emergency reserve for shut-down maintenance of the generator, whereas gaseous storage takes care of any normal variation in use pattern.

The mixed-pressure cycle is very versatile, in that by proportioning the percentage of boosted air or by changing the booster pressure, it is possible to make almost any percentage of the plant capacity as a liquid. The cooler shown refrigerates a part of the air which is taken out of the exchanger, and subsequently reintroduced. This is a simple means for providing extra refrigeration to the cycle. Applied in this way, a small unit adds safety factors in productive capacity far out of proportion to its share of the total power load. Under many types of load, an expander adds materially to the efficiency of the cycle.

This cycle further has the advantages that, where purities are important — and these are generally all 99.5 percent purity cycles, except the low pressure —we have two entirely pure oxygen streams. In addition, a nitrogen stream which comes into the shell side of the heat exchanger is also at high purity, uncontaminated by water or CO_2, and is available for special uses.

TABLE 1. Power Comparison for Various Oxygen Cycles to Produce 100 Tons per Day of 99.5 Percent Oxygen at 450 Psig.

Equipment	Low pressure cycle, hp per ton per day oxygen	Medium pressure cycle, hp per ton per day oxygen	High pressure cycle, hp per ton per day oxygen	Mixed pressure cycle, hp per ton per day oxygen
85-psi air compressor	19.65	—	—	19.65
450-psi O_2 compressor	6.62	—	—	—
550-psi air compressor	—	32.00	—	—
450-psi O_2 pump	—	0.16	—	0.16
1500-psi booster air compressor (30 percent only)	—	—	—	7.15
2500-psi air compressor (100 percent of air feed)	—	—	51.5	—
Refrigeration compressor	—	—	—	0.25
Expanders	−0.39	−0.64	−3.6	—
Total hp per ton per day	25.88	31.52	*47.9	27.21
Horsepower ratio	1.00	1.22	1.85	1.05

An air intake of 9000 std cu ft per min is assumed in each case.
***Oxygen product is removed as a liquid from the air separation equipment.**

Power Cost Comparisons

Table 1 relates all these cycles on a power-cost basis. We have assumed oxygen compressor efficiency of 65 percent; the air compressors, reciprocating type, at 75 percent; with the centrifugal type at 65 percent.

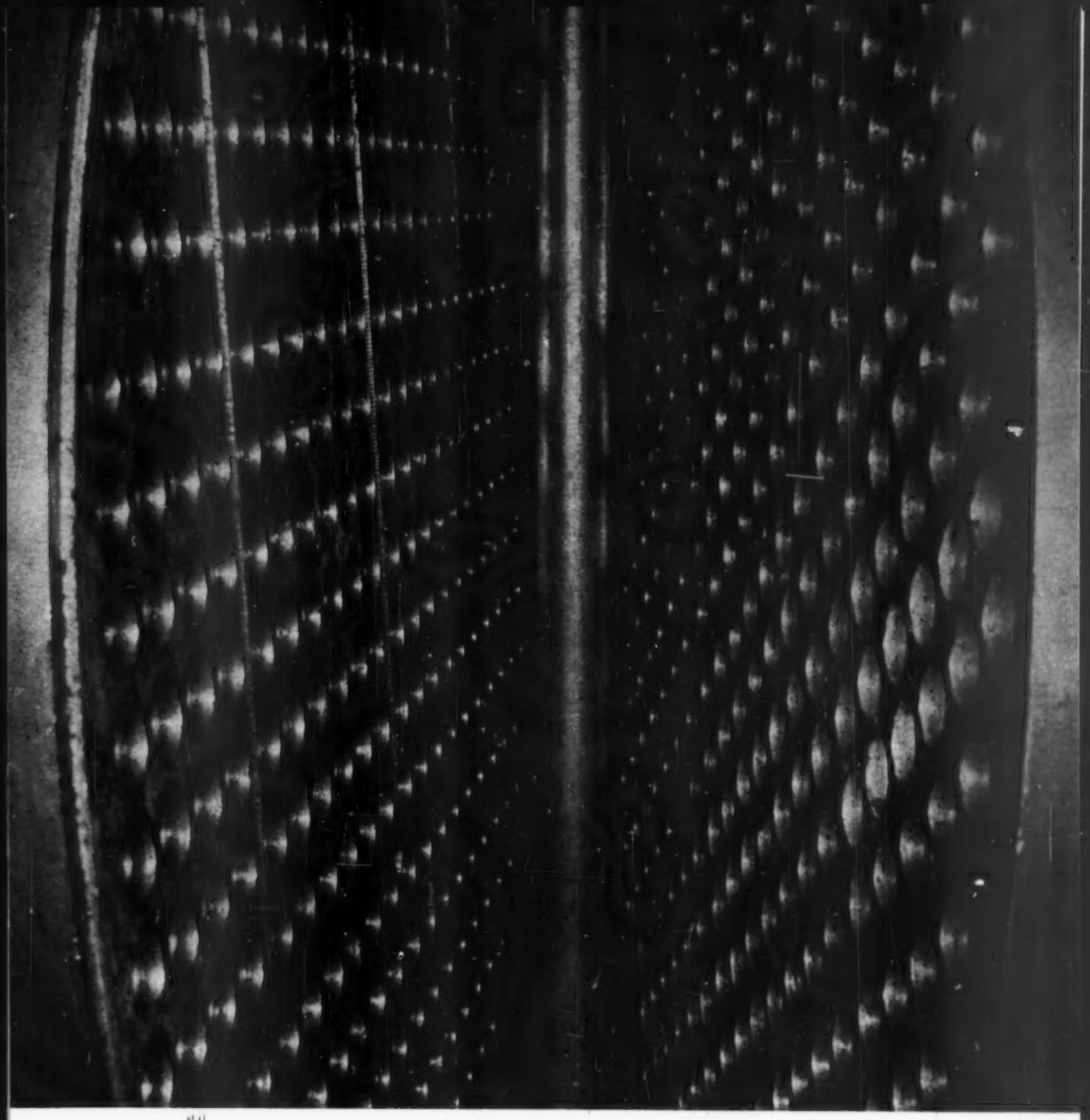
The ratio of power values is shown at bottom with the basic low-pressure cycle having a power index of one, comparative power consumption is about 22 percent higher for the medium-pressure cycle, the high-pressure cycle is 85 percent higher, and the mixed-pressure cycle only 5 percent higher.

This 5 percent is certainly a very small penalty for the flexibility which has been mentioned in terms of liquid, some high-pressure oxygen and some medium pressure.

Another advantage of the pumped oxygen plant over the low-pressure type is the inherent safety margin afforded by the continuous purging of the liquid oxygen in the condenser-reboiler, preventing accumulation of atmospheric hydrocarbons. (Atmospheric contaminants that are in any refinery or petrochemical plant.)

Other Gases

Low-temperature distillation, adsorption, fractional condensation, filtration and other unit operations are today helping processors by upgrading methane, recovering helium from natural gas (or both, including natural gasoline separations), purifying hydrogen in refinery tail gas, coke-oven gas and partial oxidation streams for ammonia manufacture, and treating purge gas for recovery of valuable fractions. The end is not yet in sight. * * *



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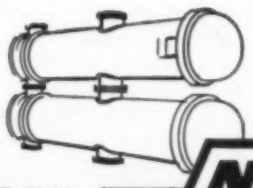

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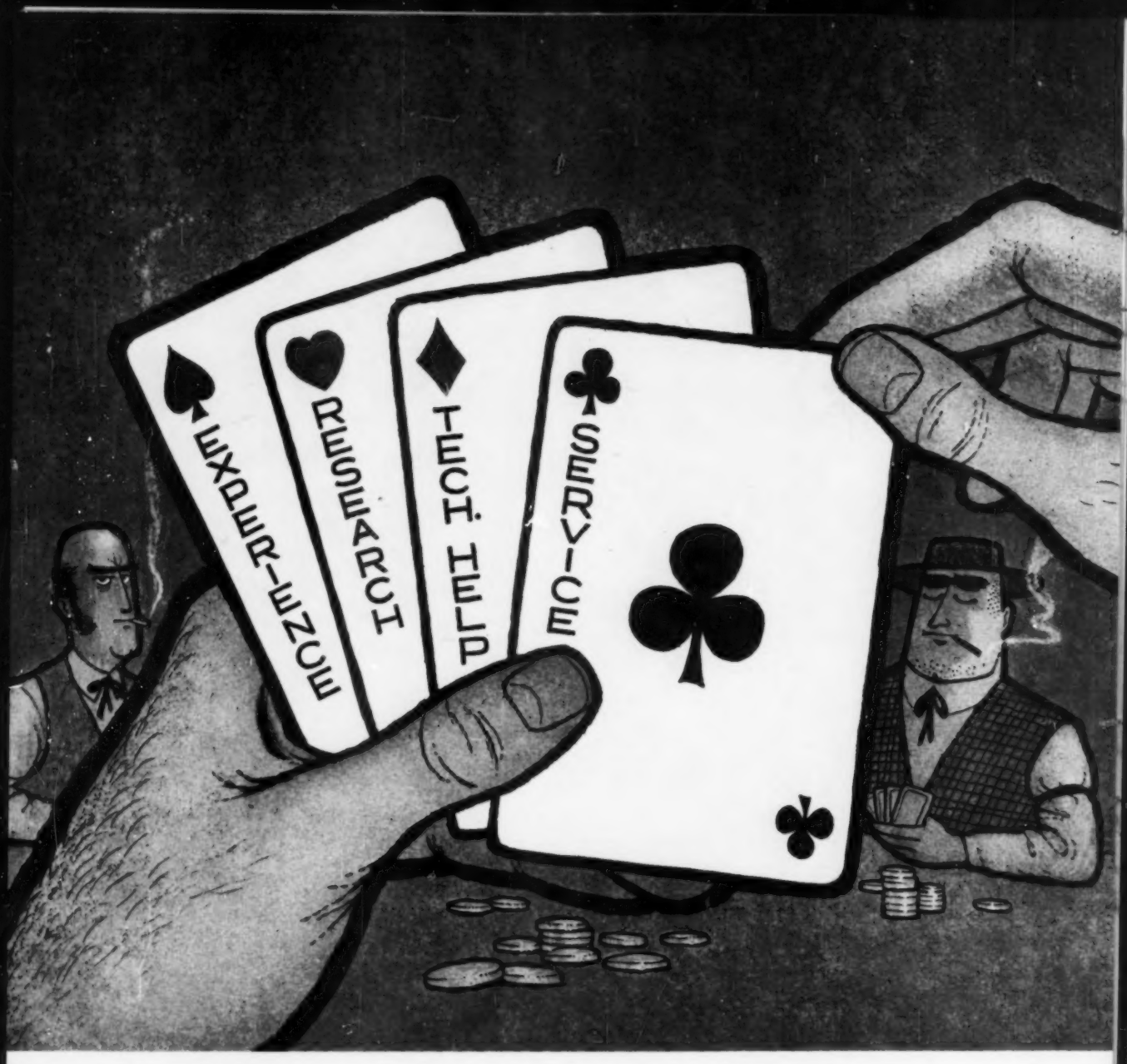

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REFINERY CONSTRUCTION MANUAL

PART 6. Mechanical Engineering and Design

. . . How Tanks, Piping and Equipment are Designed and Selected

Henry Martyn Noel *New Canaan, Connecticut*

PROCESS DESIGNS are supplemented by considerable additional engineering work, roughly described as mechanical engineering and design. This work includes determination of refinery and process unit layouts and foundation requirements, design and preparation of mechanical specifications for vessels, piping, furnaces, heat exchange equipment and all other components of the plant.

The first step is to draw up a plot plan for the entire refinery, based on a careful site survey. Arrangements of process units, tanks, utilities and shipping facilities must be planned to minimize piping runs, to provide for future expansion, and to facilitate maintenance. Scale models are frequently used in conjunction with this work, with the model usually based on the layout drawing. It is a currently-popular procedure to build the model before making detailed drawings in some instances. Drawings are prepared based on the model. Or, photographs of the model with appropriate notations may serve in lieu of a drawing.

Soil bearing values, possibility of earth tremors, wind velocities and prevailing direction, and weather conditions must be studied and taken into account by the mechanical engineers. Allowance must be made for corrosive conditions, internal and external to the equipment. Utilities requirements must be determined. Topographic studies are needed to design roads, railroads, sewers and other underground and surface piping, and foundations.

Mechanical designers are also responsible in part for arrangement of items with battery limits of a process unit, from the standpoints of economy in pumping requirements, pipe runs, ease of maintenance, and possible effects on operations of nearby units. Offsite piping, utilities, storage facilities, and other offsites are also the concern of the mechanical designer.

Storage Tank Requirements and Design

The amount of crude storage needed depends upon settling time to reduce water content, sizes of crude tankers, regularity with which cargoes may be expected, and the duration of possible supply interruptions to supply.

For a refinery supplied by large tankers from a crude source some thousands of miles distant, it is not unusual to find 20 to 30 days' crude storage — especially among smaller refineries where the delay of a single cargo might mean many days' production lost.

Product storage tanks may have more total capacity than those used for crude, but the sizes are smaller except for major products such as motor gasoline and fuel oils. In determining the number and sizes of tanks for each product, the engineer must take into consideration the regularity of liftings, the periods of stagnation, due process unit shutdowns and maintenance, and the flexibility required for shifting tank service from one product to another.

Working tankage is usually provided for each process unit, with two or three small tanks for each product to allow for receiving in one while pumping from or settling in another.

Design engineers specify location, size, type of pad or foundation, floating or cone roof, approximate sewer drawoff location, and manholes and nozzles for all tanks. It should be noted that sizes are frequently determined by studies made by the economics group in the process engineering department.

Tank Construction. Ordinary tank steel (API 12-C) is used throughout, except for very large tanks where ⅞-in. plates or thicker are needed for the bottom, where American Bureau of Ships steel (Class C, fully killed to avoid brittle rupture) may be used.

All courses are butt-welded in the tanks, from the bottom course up to the top. Welds are X-ray tested to insure integrity.

Soil bearing consultants may be used to determine if simple pads of gravel and sand may be used under the tanks, whether reinforced concrete rings are needed to retain the soil around the pads, whether reinforced concrete foundations on piles are needed . . . in which case the foundation could cost more than the tank.

Refinery Piping

The size of pipe used in the refinery is found by balancing pipe cost against power cost, with some allowance for possible future increase in refinery capacity.

Pumps are selected for a given capacity at a certain maximum discharge pressure. The design engineer must balance the additional cost of power needed for small diameter piping against the additional cost of large diameter piping needed for low power consumption. There are standard tables to cover all the usual situations found here.

The design engineer carries this piping work to the point of specifying pumping equipment. Draftsmen calculate and layout the final pipe sizes. Standard 150 lb CWC steel line pipe is commonly used in most sizes.

Refinery piping is usually laid at grade or on elevated supports to facilitate detection and repair of leaks. Concrete-lined pipe trenches holding a number of lines are used in congested areas to avoid the danger of fire spreading. Butt-welded joints are used except at valves and fittings where bolted flanges are used. Hot lines must have expansion joints or loops.

Pipeline Capacities

Pipelines handling crude oil range from 8 in. diameter for 25,000 bbl per day up to 30 in. diameter for 300,000 bbl per day. These are representative figures for average conditions on long lines.

Pump discharge pressure is usually 500 psig and pumping stations on long lines are usually about 50 miles apart. Some lines have pump pressures up to 2000 psig where the greater cost of the thick pipe and more powerful pump station are counterbalanced by the reduction in number of stations.

Within the refinery, where pipelines are usually only a few thousand feet long, total pressure drop is usually designed to be about 100 psi.

Rate of flow depends upon size of pipe and allowable pressure drop. Pressure drop varies with the specific gravity of the fluid stream, but since the specific gravity of crude

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TABLE 1. Line Capacities Based on Oil with 0.85 Specific Gravity and 10 Centistokes Viscosity.

Pressure drop, psi	—10—		—50—		—100—	—500—		—1500—	
Line length	200 ft	1000 ft	1000 ft	2000 ft	1000 ft	10 miles	50 miles	30 miles	150 miles
BPD capacity for line diam. of:									
2 in.	2,200	900	2,200	—	—	—	—	—	—
4 in.	13,700	5,700	13,700	9,100	20,000	—	—	—	—
6 in.	41,000	16,800	41,000	27,500	58,000	17,000	—	17,000	—
8 in.	86,800	34,000	86,800	59,000	125,000	35,000	14,000	35,000	14,000
12 in.	—	100,000	—	175,000	365,000	105,000	42,500	105,000	42,500
20 in.	—	—	—	—	—	410,000	165,000	410,000	165,000

TABLE 2. Line Capacities Assuming Pressure Drops of 500 psi (Long Lines) and 100 psi (Refinery Lines).
(Based on Oil with 0.85 Specific Gravity and 10 Centistokes Viscosity)

Pipeline, miles (500 psi press. drop)	Refinery Line, ft (100 psi press. drop)	ΔP/100 ft psi	BPD Line Capacity for Diameters of:						
			2-in.	4-in.	6-in.	8-in.	12-in.	16-in.	20-in.
50	—	0.2	—	2,300	7,000	14,000	42,500	91,000	165,000
20	—	0.5	600	3,800	11,500	24,500	72,000	156,000	275,000
10	10,000	1.0	800	5,700	17,000	35,000	105,000	228,000	410,000
5	5,000	2.0	1,300	8,500	24,000	52,000	152,000	330,000	—
2	2,000	5.0	2,100	13,500	41,000	85,000	250,000	—	—
1	1,000	10.0	3,200	20,000	58,000	125,000	—	—	—
—	500	20.0	4,800	30,000	89,000	182,000	—	—	—

oil and products varies only between 0.75 and 0.95 in most cases, the friction factor is usually 0.006-0.009. With this assumption, an approximate table for flow rate can be made, based only on pipe size, pipe length, and pressure drop.

Tables 1 and 2 give such data for rough estimating purposes only, for an oil of 0.85 specific gravity and 10 centistokes viscosity. The figures for flow rate might be 12 percent off for oils of other viscosities, and even more for light oils such as gasoline, or for heavy residue. For gasoline at 75 F, the figures should be increased by 30 percent. For 14.5 deg API residum at 200 F, the figures should be decreased by 30 percent.

TABLE 3. Typical Column Sizes for Average Conditions.
Not to Be Used for Estimating Purposes

Feedstock:	Column Diam.	Max. Capacity, BPD
Arabian Crude	3′, 6″	3,000– 6,000
(Preflash Tower)	5′, 6″	15,000–25,000
	8′, 0″	30,000–50,000
Arabian Crude	5′, 6″	3,000– 6,000
(Main Atmos Tower)	11′, 0″	15,000–25,000
	15′, 0″	30,000–50,000
Arabian Reduced Crude	6′, 0″	1,500– 2,500
(Vacuum Flash Tower)	12′, 0″	6,000– 9,000
	17′, 0″	14,000–18,000
Gas Oil & Cycle Oil	3′, 0″	2,000– 3,000
(15 psig Fractionator for Cracker)	6′, 0″	8,000–12,000
	8′, 6″	15,000–25,000
Light Gasoline	1′, 0″	3,000– 6,000
(300 psig Stabilizer Tower)	2′, 0″	15,000–25,000
	3′, 0″	30,000–50,000

Process Unit Design

Since there is no real substitute for detailed process engineering work in finding the proper equipment sizes for any new case, no refinery engineering organization has made any generalized table of equipment sizes. There are too many variable factors involved. To assume too many such factors would be dangerous, even for rough estimating purposes.

With these warnings in mind, Tables 3 and 4 are given only as examples of sizes of columns and furnaces for certain assumed cases. The data, for tower and furnace sizes of a two-stage distillation unit with preflash, were based on four different crudes and three different feed rates.

Assumptions inherent in Table 3 . . . any one of which could greatly change the equipment sizes . . . include degree of exchanger preheat; cut points between gasoline, kerosine, gas oil, and bottoms; reflux ratios and degree of fractionation; cooling water temperatures, and others.

The furnace sizes in Table 4 will depend not only upon heat release, but upon furnace excess air, exit flue gas temperature, heat input per unit of tube surface, and fuel combustion space allowed.

Since the cumulative effect of changing several of these factors could half or double the equipment capacity, a range of capacities is given in Tables 3 and 4 instead of single figures. Even so, Tables 3 and 4 can be regarded only as an approximate indication of sizes to be expected under a particular combination of average modern conditions.

Next month, Refinery Construction Manual's seventh chapter will discuss Mechanical Engineering and Design of Refinery Utilities.

TABLE 4. Typical Furnace Dimensions and Duties.
Not to Be Used for Estimating Purposes

Heat Release MMBtu/hr	Max. Capacity BPD	Tube Surface sq ft	Cabin Type: Outside Dimensions of Furnace, ft Width	Length	Height	Box Type: Width	Length	Height
Arabian Crude—Atmospheric Distillation								
15	3,000– 6,000	1,500	10[1]diam		40	25	20	10
60	12,000–25,000	6,000	10	30	35	30	45	15
120	30,000–50,000	12,000	12	45	40	30	80	15
Reduced Crude (40% Arabian Bottoms)—Vacuum Distillation								
7	1,500– 2,500	700	9[1]diam		35	20[2]	18	10
28	6,000– 9,000	2,800	10	20	30	25	30	13
56	12,000–18,000	5,600	10	35	35	34	40	15
Gas Oil and Cycle Stock—Thermal Cracking								
15	2,000– 4,000	1,500	10[1]diam		40	25	35	10
60	8,000–16,000	6,000	18	40	40	35	50	15
120	16,000–30,000	12,000	20	60	45	35	80	20
Heavy Naphtha—Thermal Reforming								
15	1,500– 3,000	1,500	10[1]diam		40	25	35	10
60	6,000–12,000	6,000	18	40	40	35	50	15
120	12,000–20,000	12,000	20	60	45	35	80	20
Lubricating Oil—Rerunning								
7	1,500– 3,000	900	9[1]diam		40	20[2]	22	12
28	6,000–12,000	3,500	10	25	30	25	35	15
56	12,000–20,000	7,000	10	35	35	28	45	15

[1]Vertical-type.
[2]Box-type penalized by low duty for size.

Monel Bubble Cups and Tray for top of new fractionating tower completely engineered and fabricated by Fritz W. Glitsch and Sons, Inc., Dallas, Texas. Notice Monel weirs and baffles.

Here's where Monel proves year-after-year resistance to common tower-top corrosives

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Today, for towers handling corrosive streams, Monel alloy is preferred in this location.

The men with the sharp pencils say Monel alloy costs less per pound than other commercially available alloys able to withstand the corrosion in tower tops.

Fabricators such as Fritz W. Glitsch & Sons, Inc., find it is easy to form . . . lends itself well to lined or clad construction. Increasingly, they find it specified not only for caps and trays but also for distribution pipes, fittings, linings, the shell itself and overhead condensers.

Another advantage. Monel equipment can be field erected and easily repaired in the field. No heat treatment after welding is required to maintain corrosion resistance.

How is your tower down-time record? If it's not what it should be and corrosion is the cause, look into the possibilities of Monel alloy construction. Simply write Inco's Corrosion Engineering Section. *Registered trademark

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Perco HF Alkylation

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DESCRIPTION: Essential features of this HF Alkylation Process for the production of motor fuel from a propylene-butylene feedstock are shown in the flow diagram. With minor variations this design may be used with any olefin feedstock to produce either motor fuel or aviation gasoline.

Liquid feed containing olefins and isobutane is passed through bauxite driers and fed into the lower section of the reactor, while the liquid hydrofluoric acid enters the reactor through a recycle line connected to the bottom of the reactor. The alkylation reaction is completed by intimate contacting, after which the hydrocarbon and acid flow to the settler where a two-phase separation occurs. The acid phase is recycled to the reactor. The hydrocarbon phase is fed to the fractionating section where the propane and recycle isobutane are separated from motor fuel alkylate.

The reactor effluent is water-cooled to a temperature of 85 to 95°F, depending upon seasonal changes in cooling water temperature. Variation within this 10°F temperature range does not have an appreciable effect on either product quality or operating cost. The acid-hydrocarbon ratio of the reactor feed is not critical and may range from 0.2:1 to 1:1. For the purpose of product quality control, an excess of isobutane is recycled to the reactor with the olefin. External isobutane-to-olefin ratios from 2:1 to 20:1 have been used but for motor fuel production the optimum will be approximately 7:1.

As an auxiliary to the operation, an acid rerun is provided for continuously purifying the hydrofluoric acid catalyst by the fractionation of a small portion of the circulating acid stream. The acid soluble oil production is so small that it can be easily disposed of in furnace fuel without further neutralization.

FEEDSTOCK & YIELDS:

Typical operation for a propylene-butylene cut from a catalytic cracking operation based on 100 B/D total feed is shown.

Charge to Unit	Bbl. Feed	Bbl. Product
Propane	7.5	9.8
Propylene	11.5	—
Butylene	20.4	—
Isobutane	46.4	2.3
N-Butane	14.2	14.2
Alkylate	—	56.2
TOTAL	100.0	82.5

TYPICAL PROPERTIES
DEBUTANIZED MOTOR FUEL ALKYLATE

Gravity, °API	68.8
ASTM Distillation, °F	
IBP	160
10% evap.	199
20% evap.	210
50% evap.	224
90% evap.	264
95% evap.	336
E.P.	392
Color, Saybolt	30
Doctor Test	Negative
Corrosion, 122°F	Negative
ASTM Gum	0.4 Mg/100 Ml.
ASTM Research Octane Number	
Clear	92.5
1 ml TEL	99.5
3 ml TEL	103

OPERATING SERVICE FACTOR: 98%

SUMMARY OF DIRECT OPERATING EXPENSE:

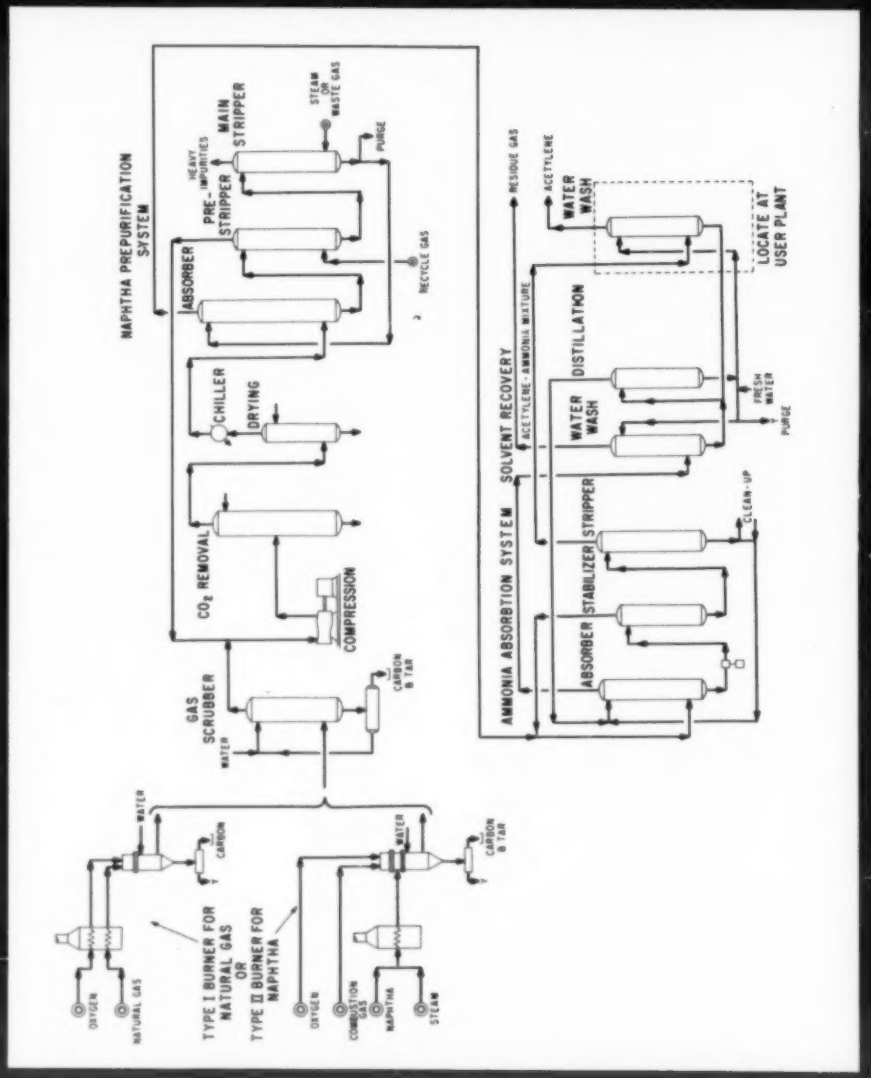
	Unit/Bbl. Alky.	$/Bbl. Alky.
Operating Labor (2 Men/Shift)		0.0800
Supervision & Laboratory		0.0800
Repair Labor & Materials		0.1600
UTILITIES		
Fuel @ $0.10/MM BTU	0.53 MM BTU Absorbed	0.0757 (70% eff.)
*Water Circulation @ $0.015/M Gal.	3.56 M Gal. —20° Rise	0.0534
Make Up Water @ $0.09/M Gal.	0.07 M Gal.	0.0063
Electrical Power @ $0.0057/KWH	3.50 KWH	0.0200
*Includes Power and Treating		
CHEMICALS		
Caustic @ $0.035/Lb.	0.1430	0.0050
HF Acid @ $0.21/Lb.	0.2700	0.0567
Miscellaneous		0.0100
TOTAL		0.5471

INVESTMENT:

Investment will range from $750 to $1000 per barrel of alkylate produced, depending upon the type of feedstocks and desired motor fuel yield, (i.e., a debutanized motor fuel blend stock, etc.).

SBA-KELLOGG Process for Acetylene Production

Licensed by: The M. W. Kellogg Company



The Refining Engineer's Process Notebook

SBA-KELLOGG Process for Acetylene Production

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DESCRIPTION: The new acetylene processes developed by Societe de l'Azote (SBA) of Belgium and Kellogg produces high purity acetylene from natural gas, naphtha, or other feedstocks. There are two processes, one for natural gas, the other for liquid feedstocks. Major difference between the processes is in design of the burners that convert feed to a dilute pyrolysis feedstock. Both methods use the SBA-developed recovery and purification process, with slight differences depending on reactor feed. Further discussion and data here are limited to gas feeds.

Production of acetylene from methane and methane-rich streams such as natural gas is basically a condensation reaction. The extremely high temperatures required are obtained by partial combustion of the feedstock. In addition, feed pre-heat is used to minimize amount of combustion, improve yields, and increase acetylene concentration in reactor product to the recovery step.

General limitations on acetylene yields are: (1) Temperature at which preheated O_2 and CH_4 can be introduced to the burner without preignition and flashback; (2) Heat losses in the burner; and (3) Control of reaction time to optimize yield and prevent acetylene destruction by overcracking.

The Type I burner uses a simplified mixing principle which requires a smaller, less-complicated mix-chamber and also permits operation at elevated preheat temperatures for maximum yields. Reaction chamber design minimizes carbon formation from overcracking. A water screen continuously removes carbon from the burner. An all-metal burner is used; it requires no refractories and needs little maintenance.

The recovery section can produce a 99.8% pure acetylene, with higher purities attainable if desired. Low-cost, readily available solvents are used, with ammonia being the major recovery solvent.

Conditions have been selected to minimize polymerization of higher acetylenes. Higher acetylenes are rejected by a pre-purification system. This approach virtually eliminates polymerization and equipment fouling. Recovery unit design is flexible and can be adapted to any range or combination of feedstocks. It should be noted that only slight plant design modifications are required should a liquid-type burner be installed in place of a gas burner.

Tail gas from the recovery unit is hydrogen-rich and thus an attractive feedstock for manufacture of methanol, ammonia, etc. Units can also be engineered to recover ethylene produced from liquid feedstocks.

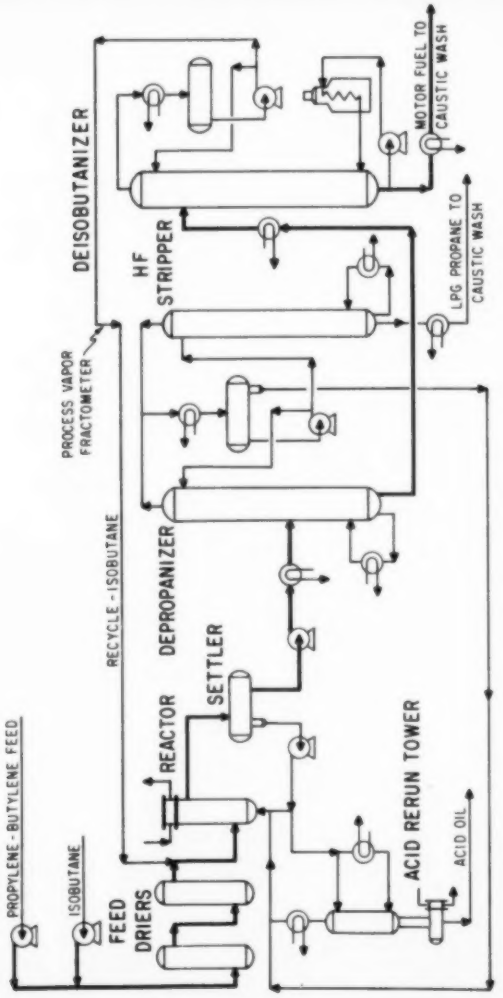
OPERATING COSTS AND ECONOMICS FOR PRODUCING 99.6% ACETYLENE FROM NATURAL GAS

Capacity, Million Lbs/Yr	20		60	
Investment[1]	$4,000,000		$7,800,000	
Direct Operating Cost	$/Yr	¢/Lb	$/Yr	¢/Lb
Labor: 4 Men/Shift[2]	95,000	0.48	95,000	0.16
Steam @ 40¢/1000 #	111,500	0.56	334,000	0.56
Power @ 0.8¢/KWH	16,000	0.08	48,000	0.08
Cooling Water @ 1.0¢/1000 gal	38,000	0.19	114,000	0.19
Fuel Gas @ 20¢/MM Btu	26,000	0.13	78,000	0.13
Chemicals & Solvents	148,000	0.74	444,000	0.74
Maintenance @ 4% of Investment	160,000	0.80	312,000	0.52
Total	594,500	2.98	1,425,000	2.38
Economics of Production				
Feedstock @ 20¢/MM Btu	400,000	2.00	1,200,000	2.00
Oxygen[3]	404,700	2.01	820,100	1.37
Direct Operating Cost	594,500	2.98	1,425,000	2.38
Prop. Tax & Ins. @ 3% of Investment	120,000	0.60	234,000	0.39
Interest @ 4% of Investment	160,000	0.80	312,000	0.52
Total Debits	1,679,200	8.39	3,991,100	6.66
Tail Gas Credit @ 20¢/MM Btu[4]	240,000	1.20	720,000	1.20
Net Cost	1,439,200	7.19	3,271,100	5.46

1. Acetylene unit only, exclusive of oxygen unit, services and offsites.
2. Includes supervision.
3. Costs vary with quantity required. Consumption (100%) is 5.3 tons O_2/ton of acetylene from natural gas.
4. Includes ethylene at fuel gas equivalent.

Perco HF Alkylation

Licensed by: Phillips Petroleum Company



OPERATOR'S FORUM

What Fuel Oil Tests Are Best?

Q In testing sludging qualities of No. 2 fuel oil, are visual microscopic tests better than tests such as Conradson Carbon Residue on 10 percent bottoms from an ASTM Distillation or other tests which physically measure deposition?

A The range of most commercial No. 2 fuel oils have Conradson Carbon Residue on 10 percent bottoms in the range of 0.05 to 0.36 percent with an average of 0.20 percent. Extended burner tests on those suitable for No. 2 fuel oil show that in a well designed appliance the Conradson carbon number has little influence on their operation but proper storage stability is of utmost importance. Good cut-off valves, correct air mixing, and in certain cases nozzle shielding are necessary for a burner to reduce nozzle carbon build-up and combustion chamber deposits to a minimum. To state that only No. 2 fuel oils of the lower Conradson Carbon values shall be used to reduce the rate of burner carbon deposit build-up lies with the burner in most cases, not with the carbon residue on the 10 percent bottoms of the fuel.

Storage Stability Key Problem

In the case of No. 2 fuel oils for domestic heating or diesel engines, which represents the bulk of the distillate fuel oil market, the main problem is one of storage stability. A stable fuel oil is one in which flocculation does not occur or in which deposits mainly of an asphaltic or gummy nature are not produced during service or in storage. Some No. 2 fuel oils may produce or precipitate 8 mg per 100 cc of sludge in one month's storage at 100 F. This compares with 1 mg per 100 cc or less for a premium fuel oil. Sludge formation results from fuel oil instability, however, the transparent gel like deposit results from the reaction of mercaptans sulfur compounds in the fuel oils with the copper in the brass parts of the fuel system. The gumming hydrocarbons which cause sediment in No. 2 fuel oils will be driven off during the Conradson Test on the bottoms. Rerunning to reduce the carbon content often fails to effect improvement in storage.

Predicting Stability, Compatibility

Keen interest has developed in predicting the compatibility and storage stability of cracked and straight run fuel oils. Cracked distillates, raw, usually deteriorate faster than straight run distillates, consequently there is a need for a dependable stability test to predict whether a batch of fuel will have adequate storage stability. The OHI (Ohio Heat Institute) Technical Division advised the ASTM Committee E on Burner Fuel Oils the urgent need for a test method for determination of No. 2 fuel oil stability in storage and set limits, maximum. This project in the ASTM is underway. Such a control of storage stability is necessary, says the OHI, to meet their new objective of "Once-A-Year" service for heating oil accounts. A better No. 2 fuel oil will eliminate one cause of burner service calls.

Microscopic Examination

Some of the railroads are using electron microscope to aid them in the stability evaluation of distillate fuel oils and blends. The use of the electron microscope has caused some controversy and discussion relative to its application. This has been brought about because dispersion of particles is desired and large agglomerates are believed harmful, but no precise correlation between electron microscope results and field experience exists. The same desirable item in conjunction with this instrument is a procedure for accelerating the aging of the fuel for checking the insoluble amount after aging, for predicting the storage stability.

Accelerated Stability Test

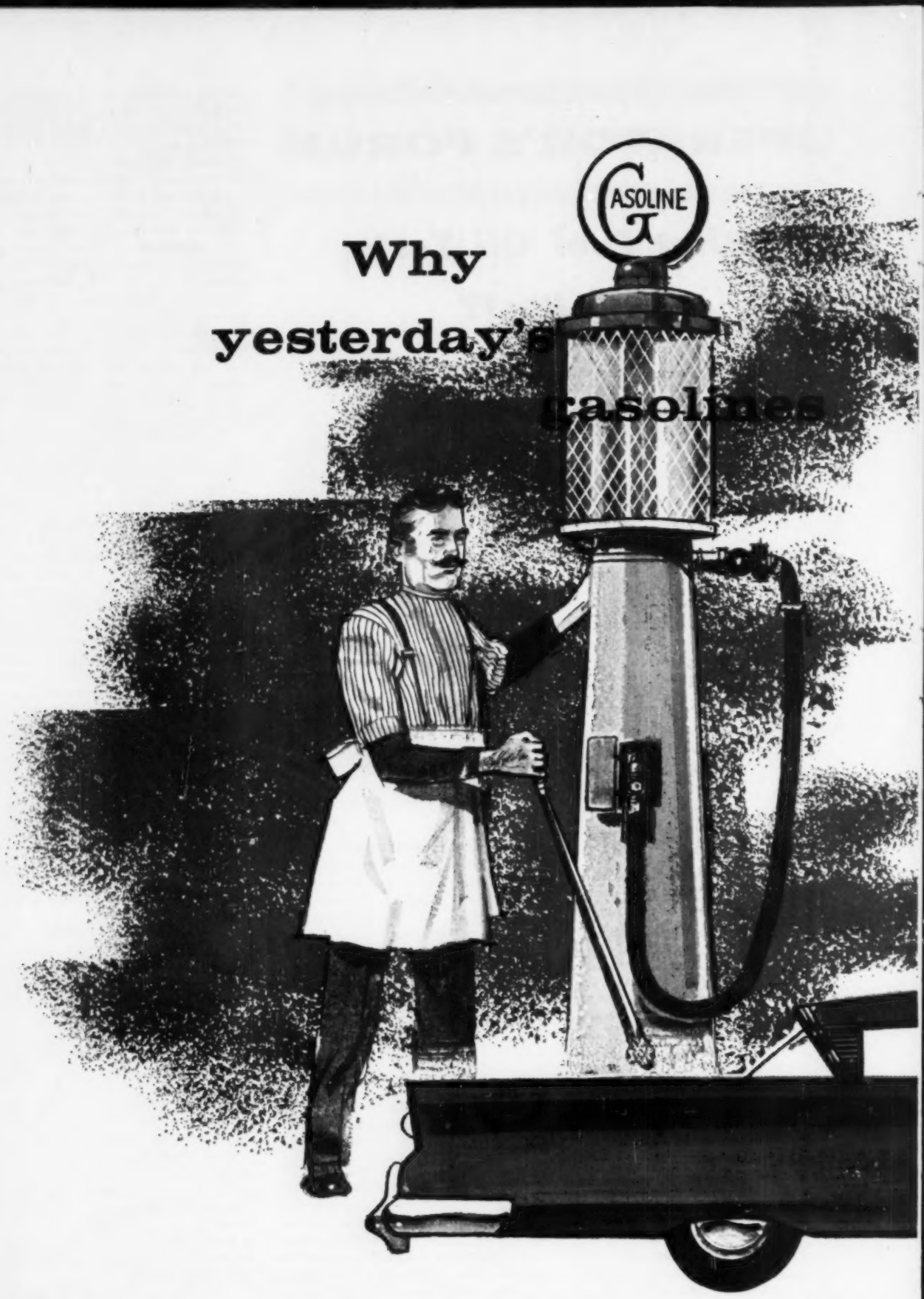
Most of the major oil companies are using accelerated stability tests setting maximum limits of sediment throw out. These tests indicate potential insoluble gum or sediment for such heating oils. These tests are conducted by placing about 600 gm of sediment free fuel oil into a clean one quart white glass bottle properly sealed and then stored in an agitated bath at 210 F for 16 hours. The stability of the test fuel oil is reported in milligrams of insoluble sediment formed after 16 hours storage at 210 F. In other instances accelerated stability heat tests pass the aged oil through 400 mesh screens and reports the hours to plug, or store a gallon of oil at 212 F for 96 hours and reports the time of flow of fuel oil through a 100 mesh screen by gravity. Through their own respective tests the majors have a reasonably reliable control test which has reduced greatly customer complaints and service calls due to freedom of filter, screens, and nozzle clogging deposits.

The most ambitious program carried out is by the Navy-CRC Diesel Fuel Stability Cooperative Group. This group analyzed the original fuels and samples of the fuel after specified periods of storage in barges, drums, and bottles over periods of 12 to 18 months in terminal and marine storage and 12 to 13 weeks in glass bottles. Each of the 14 laboratories was required to determine insoluble gum, soluble gum, and percent light transmission on each of the fuels before storage and at each interim sampling period, and to make any other test that the laboratory was equipped to make that would contribute to the value of the program. Seven fuels, straight run and catalytically cracked No. 2 type fuels from three major crude fields were selected. These base fuels were used to prepare 12 blends of fuels with the desired range of stability. Much could be written about these storage stability tests. It was felt that bottle storage at 110 F for a period of 12 or 13 weeks was a rough equivalent of one year storage in the laboratory in vented drums.

Reproductibility Problem

Reproducibility between laboratories leaves much to be desired. The latest report states that the laboratory samples to date show some correlation has been noted on soluble gum but none on insoluble gum since the residue in the tanks comprises a large part of the insoluble gum generated by aging as well as metal and water contamination. Progress is being made in evaluation of storage stability. It is only a question of time before a potential sediment test will be standardized and control limits developed for No. 2 fuel oils so that all cracked fuel or blends with straight run can be treated and/or additive corrected so they are entirely suitable for domestic oil burners and diesel engines, regardless of the extent of their practical storage period.

C. M. Larson



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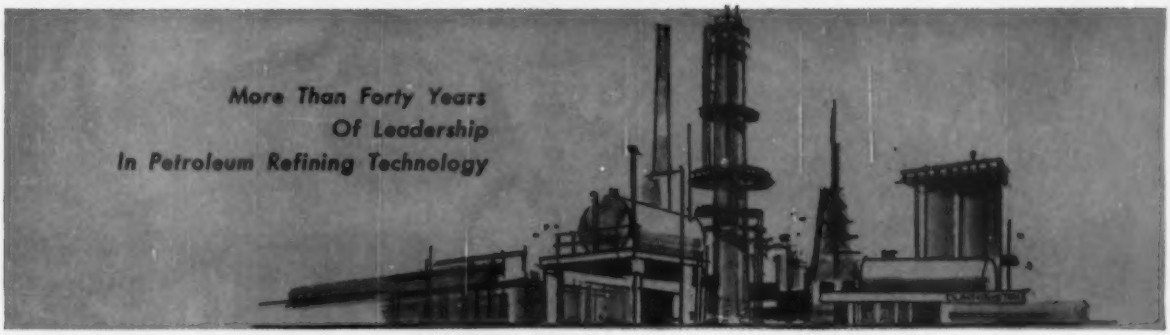

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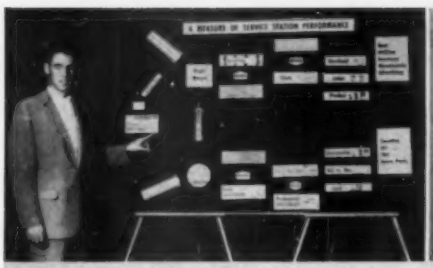
DU PONT *Petroleum Chemicals* NEWS

Number 93 in a Series of Bulletins for the Petroleum Industry

DECEMBER 1958

Three oil industry presentations by DuPont win first-place awards for effectiveness



"A Measure of Service Station Performance"

"What Every Woman Should Know About Her Car"

"Dollars and Sense"

TOPS FOR TRAINING: DuPont presentations for the oil industry which won first prizes in 1958 visual aids competition

Three training presentations widely used in the petroleum industry have won first-place awards in the 1958 visual aids contest of the National Visual Presentation Association.

Created as part of the DuPont sales and service program for refiners and marketers, these prize-winning presentations topped all others in three of the six categories in the Graphics competition.

All three prize-winning programs are available to oil companies for dealer orientation, service station training, or good-will showings to groups of consumers.

"*A Measure of Service Station Performance*" won first place in the "Employee Training" category.

It is a flannelboard presentation created to simplify and explain the economic factors which realistically measure the success of a dealer in terms of "per cent return on investment." It can be given as a three-hour discussion program, or as two 1½-hour sessions, or in short form as a 30-minute lecture. The longer versions include the use of a worksheet which helps each member of the audience to measure his own performance.

"*What Every Woman Should Know About Her Car*" took first-place honors in the "Public Relations – Education" class.

This "flackboard" (flannelboard and blackboard combined) presentation was created to increase greatly the public's confidence in their service station operators. It explains in simple terms the mechanical features of the modern automobile, and tells how women can keep their cars operating dependably with the help of their dealers' knowledge. It tells what must be attended to – why – and when, and convincingly shows that the cost of this regular maintenance is much lower than various types of insurance – only about 7/10¢ per mile.

"*Dollars and Sense*" is a flannelboard presentation which explains the everyday problems of all businesses – large and small. It won first prize in the "Employee Relations" category.

Oil helps make Christmas merrier for millions

Many of oil's chemical offspring will play a big part in making Christmas a happy occasion around the world this year.

Nylon, for example, will find its way under millions of Christmas trees – as molded parts in *Junior's train*, in *Dad's power tools*, and in an infinite variety of garments from *stretch socks* to *dolls' clothes*.

"Dacron" polyester fiber, another product made partly from oil, will turn up in everything from *shirts* to *slacks*, *loungewear* to *lingerie*.

And many, many more products derived from oil will contribute to happiness at Christmas this year.

These products are the results of constant experimentation and research, with oil and its derivatives. At DuPont, chemistry helps turn oil into exciting new products. This spells an ever increasing demand for petroleum in the years to come.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DUPONT *Petroleum Chemicals* NEWS

You ought to know...

FENTON RUSSELL, M.D., has, by his own admission, "not discovered anything and has invented nothing."

Yet as a member of DuPont's Medical Division, Dr. Russell plays a role that is of importance to every refiner who uses tetraethyl lead. Travelling distances which would amaze the busy circuit-riding doctor of the past, he works closely with refinery managements, physicians, supervisors and blenders to help them maintain the very finest health and hygiene programs.

Dr. Russell also participates in many of the DuPont Training Programs conducted in refineries, to teach safe and proper methods of unloading and blending tetraethyl lead.

He joined the DuPont Company in 1943 and participated in the wartime Manhattan Project at Hanford, Washington. Later he moved to the DuPont Medical Division to pursue his special interests, Legal Medicine and Toxicology. Dr. Russell received both his B.S. and M.D. degrees from the University of Pittsburgh.

His friends know that he "loves to make a speech" – which should lend encouragement to refiners who might want to use the services of Dr. Russell to augment their own safety training programs.

GASOLINE AND TBA CUSTOMERS in new DuPont film often find themselves more comfortable in one station than in any other.

"Know your customer" motion picture helps dealers use psychology in selling

"Gee . . . he picked my station!" enthuses the typical service station operator, in DuPont's new full-color semi-animated strip-film.

Then he learns *why* his customers choose him . . . what makes a customer tick. The information in this 10 minute presentation is based on the nationwide survey of service station patrons which was conducted for DuPont by psychologists from National Analysts, Inc.

In the survey—and in this screenplay – the *real* reasons for station selection are revealed. For example, the patron who drives past station after station across a city to go to his favorite dealer's because it is "convenient" is actually motivated by his feeling that this particular dealer is really interested in him and his car.

And the woman who goes to a station "because it is convenient" often has an even deeper reason – in some service stations she is treated with patience and helpfulness, not being made to feel uncomfortable in a strange man's world of mechanical mysteries.

This sound film, with its likeable characters and sprightly action, carries its message simply, with force and good humor. It is ideal for dealer-orientation meetings, for which it is readily available. Simply contact your DuPont representative and he will arrange showings for you.

CONTINUED

First Place Awards

Purpose of this visual aid is to help improve relationships between oil companies and dealers, by helping dealers to understand our free enterprise system in the light of problems shared by business of all sizes, with some predictions about the future of the service station business.

Kits for these presentations are available, complete with detailed scripts. Any speaker can use them with a minimum of preparation.

For further information about these –or the more than 30 other sales services we offer–write to Petroleum Chemicals Division of the DuPont Company.

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OVER

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PRACTICAL EXPERIENCE

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Stearns-Roger has for years been closely identified with the oil and gas industry. Processing plants designed and built by Stearns-Roger operate from the extreme cold of Canada to the mild conditions of the Texas Gulf, ranging from the very large to the very small.

Starting with analysis of well-head gas, S-R facilities are complete for handling each successive step through process design, general engineering, fabrication of special equipment in our shops, and field installation with our own personnel. We deliver a completed plant, operating, to meet the customer's long term needs.

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BETTER AIR CONDITIONING FOR EVERYBODY EVERYWHERE

Carrier

Carrier multi-level refrigeration saves $60,000 in installation costs!

Problem: To provide propane refrigeration at four temperature levels—minus 35° F, minus 3° F, plus 28° F and plus 64° F—in a southwestern natural gas extraction plant.

Conventional solutions: (a) Install four separate compressors. (b) Install two compressors. (c) Install one compressor with no side loads.

Carrier solution: Install a single Carrier Centrifugal Compressor with side loading.

Installation savings: Savings on the installed cost of the single Carrier Centrifugal, exclusive of drivers and their installation costs—in comparison with the conventional solutions (a) $60,000. (b) $28,000. (c) No installation savings, but note big horsepower savings below.

Horsepower savings: Power savings resulting from use of the Carrier Centrifugal—in comparison with (a) none. (b) 1230 hp. (c) 3400 hp.

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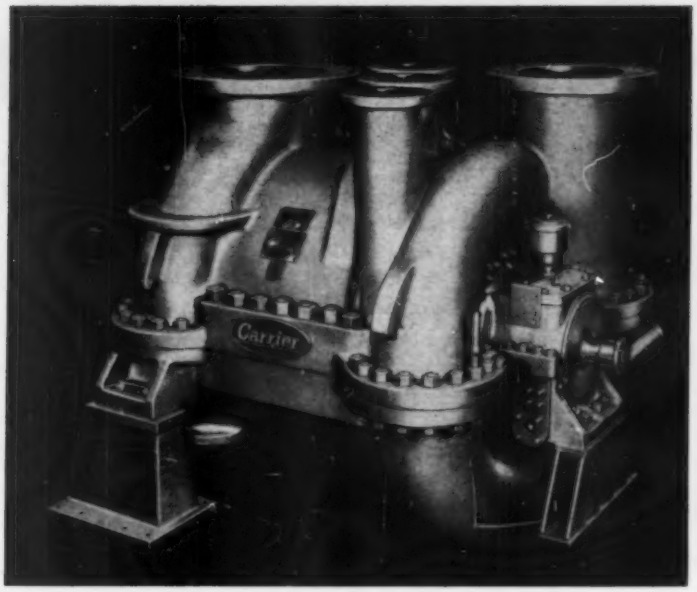
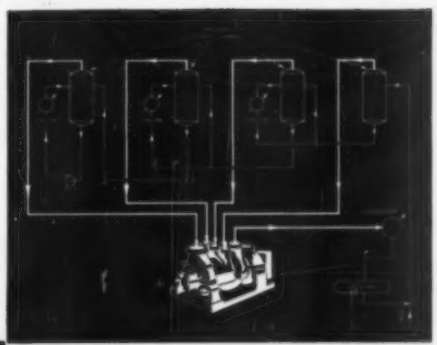
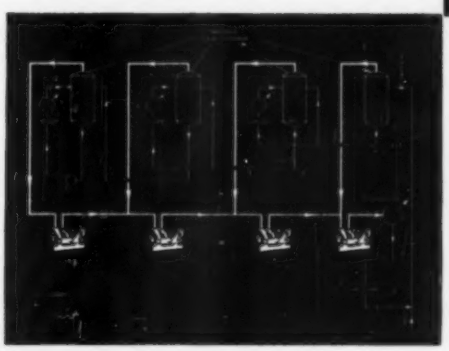


Multi-stage, heavy-duty Carrier Centrifugal Compressors with broad application flexibility are available in capacities up to thousands of tons, depending on your requirements.

Now you can effect substantial savings in horsepower and installation costs by using a single Carrier Centrifugal Compressor for refrigeration in many processing applications. These multi-stage, heavy-duty compressors provide definite installation and operating advantages. For example. Side loading for split load requirements. Extreme flexibility of arrangement with coolers and condensers. High lift or wide temperature range in two to nine stages. Variable inlet guide vanes for capacity control. Suitable for all types of drives. Versatile use with any high-pressure refrigerant.

These big-tonnage compressors are built to the same high-quality standards that have earned Carrier the reputation for round-the-clock dependability in thousands of installations. Carrier specialists draw on experience unmatched in the field. For specific recommendations for your requirements, call the Carrier office nearest you. Or write Carrier Corporation, Syracuse 1, New York.





In a natural gas extraction plant in the Southwest, one Carrier Centrifugal Compressor handling four gas streams with side loading accomplishes the same results as four separate compressors. Compared with the conventional installation, savings on installed cost of the Carrier unit totaled about $60,000, exclusive of driver installation costs.

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unequaled –

Simplest installation — orifice flange tap connections at standard spacing, are provided at both ends.

Drain and vent holes at lowest and highest points on both sides.

Purged cover protects transmitter from weather, dust, and fumes.

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By introducing the modern concept of high speed flow measurement and control, these differential pressure transmitters have *revolutionized* many an industrial process. Bulletin 13-11A shows how — and portrays the benefits the d/p Cell Transmitter offers you. Write The Foxboro Company, 6412 Neponset Ave., Foxboro, Mass., U.S.A.

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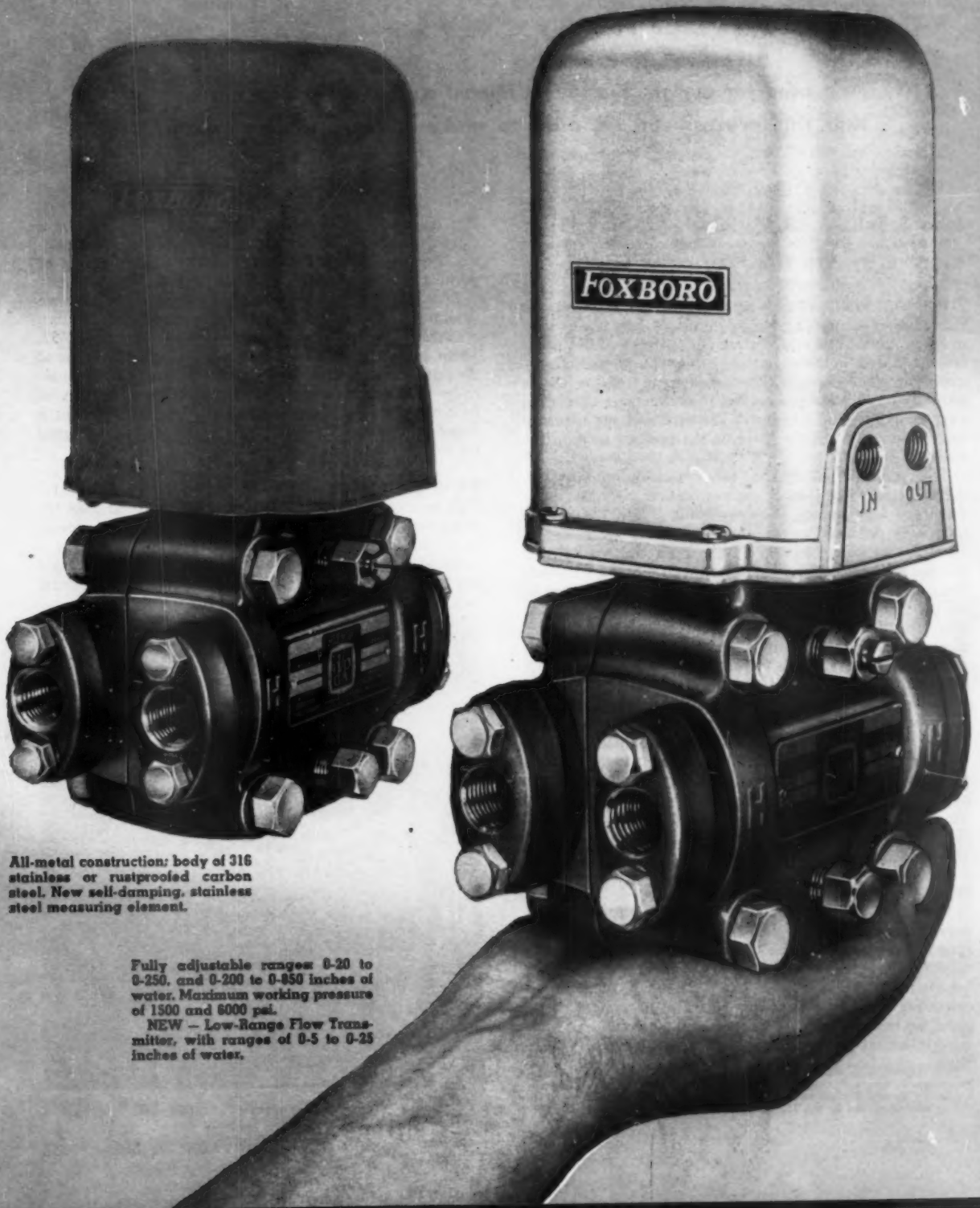

All-metal construction: body of 316 stainless or rustproofed carbon steel. New self-damping, stainless steel measuring element.

Fully adjustable ranges: 0-20 to 0-250, and 0-200 to 0-850 inches of water. Maximum working pressure of 1500 and 6000 psi.

NEW — Low-Range Flow Transmitter, with ranges of 0-5 to 0-25 inches of water.

Compounds 99.9 percent pure have been made . . .

ZONE MELTING
—New Purification Tool

First used for metals, Bureau of Mines' studies described here show that this process can be used to make ultra-pure petrochemicals

John S. Ball R. V. Helm C. R. Ferrin
Petroleum and Oil Shale Experiment Station, Bureau of Mines, U. S. Department of the Interior, Laramie, Wyoming

ZONE MELTING, which was developed by Bell Telephone Laboratories for making ultra-pure metals, has possibilities in many other fields where a premium is placed on purity. One example is in the attainment of high-purity petrochemicals and other organics. Zone melting or refining as an auxiliary purification process has the advantages of simplicity, versatility, and efficiency. The nature of the impurity to be removed has little effect on the process, in most instances.

The process, originally used for purification of alloys and metals,[1-3] has been used in the purification of organic substances.[4-7] Compounds of purity better than 99.9 percent have been produced in the Bureau of Mines laboratory at Laramie, Wyoming, using relatively simple apparatus.

Zone melting is applicable to compounds that are crystalline or that can be crystallized under the conditions used in the process. Little attention is required during operation so that repetitive operations to attain very high purification can be used without greatly increasing cost. Equipment and manpower costs for zone melting are lower than for most separation processes.

Examples will be presented here describing successful purification of three nitrogen compounds. Two are high-boiling compounds whose purification by distillation would be difficult because of the high temperatures involved. The third, a liquid at room temperature, contains impurities that boil very close to the boiling point of the compound and would consequently be difficult to separate by distillation. Equipment, handling techniques, and operating variables are also discussed.

How Zone Melting Works

When a liquid freezes, the first crystals to form are the purest; the impurities are thus concentrated in the liquid. In zone melting, a liquid zone is moved through a column of solid, from one end to the other. This is done by melting the solid in the direction of movement and allowing the liquid to crystallize behind the zone (Fig. 1). This movement transports the impurities to the bottom of the column.

An essential requirement for this type of purification is that the compound exists in a crystalline form, or that it can be crystallized by cooling. Solids, such as glass or plastics, that do not have a definite crystalline form, cannot be purified by zone melting.

Zone melting has been successfully used in the Laramie laboratory for purification of nitrogen compounds, as part of American Petroleum Institute Research Project 52, "Nitrogen Constituents of Petroleum." One of the aims of the project is to prepare highly purified nitrogen compounds to be used for comparison standards. About 1.5 liters of each compound in purity greater than 99.9 mole percent is required. The equipment to be described has been designed for this particular purpose.

Design and Operating Factors

Some factors in designing the apparatus depend upon the compound to be purified. If it is a solid at room temperature, ambient temperature can be that of the room; if it is a liquid, ambient temperature must be below its freezing point. If the compound adheres strongly to glass, a metal

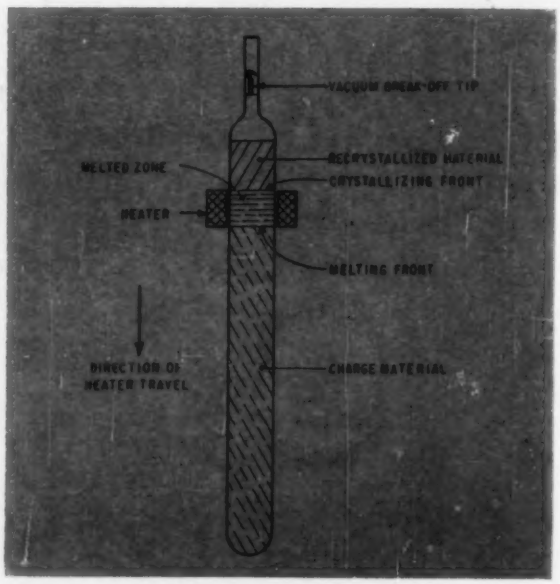

FIG. 1. Zone melting purification unit.

This investigation was performed as part of the work of American Petroleum Institute Project 52, on Nitrogen Constituents of Petroleum, conducted by the Bureau of Mines in Laramie, Wyoming, and Bartlesville, Oklahoma, and by the University of Kansas at Lawrence, Kansas.

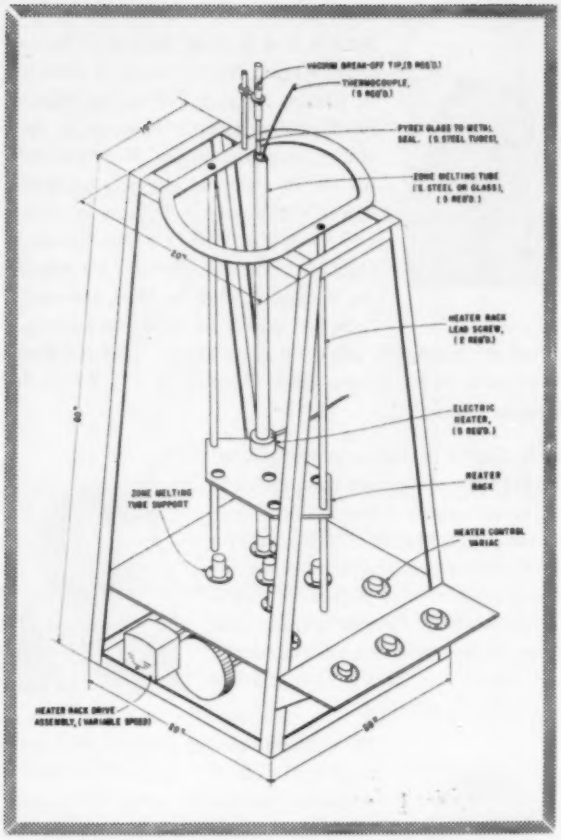
THERMOCOUPLE, (5 REQ'D.)
PYREX GLASS TO METAL SEAL. (5 STEEL TUBES)
ZONE MELTING TUBE (5 STEEL OR GLASS), (5 REQ'D.)
HEATER RACK LEAD SCREW, (2 REQ'D.)
ELECTRIC HEATER, (5 REQ'D.)
HEATER RACK
ZONE MELTING TUBE SUPPORT
HEATER CONTROL VARIAC
HEATER RACK DRIVE ASSEMBLY, (VARIABLE SPEED)

FIG. 2. Apparatus used for zone melting experiments.

column is necessary to prevent breakage. If the compound reacts with air, precautions must be taken such as vacuum operation.

Consideration has been given to some of the variables in this method of purification, but an exhaustive study has not been made. Variables include size of tube, length and temperature of zone, speed of zone travel, number of passes, and ambient temperature. Effectiveness of each pass appears to depend upon the approach to equilibrium; consequently, the slower the zone travel, the better the purification. Additional passes and larger diameter tubes improve the purification.

Apparatus and Procedure

The zone-melting apparatus shown in Fig. 2 is used with compounds having melting points above room temperature. Five tubes, either glass or stainless steel, up to three in. in diameter and 50 in. long, may be used at the same time. Tubes containing the compound to be purified are supported in an upright position and heaters are passed down the tubes at a controlled speed. Time for one pass may be varied from 12 to 50 hr. A section of the solid in top of tube is melted, and this liquid zone is moved down the tube, allowing material to crystallize above the heaters. Successive downward passes of the heaters are made until desired purification is accomplished.

Zone-melting equipment for purification of compounds that crystallize below room temperatures has been developed. It consists of a dewar flask containing a refrigerant surrounding an air bath in which the zone-melting tube is supported in an upright position (Fig. 3). After the sample has crystallized, the heater is lowered down the tube, using the drive mechanism of the regular zone melting apparatus and a system of pulleys.

Before purification, a nitrogen compound is completely degassed and sealed under vacuum in the zone-melting tube. After purification, the tube is supported in an inverted position and sealed to a glass manifold system through the vacuum break-off tip. Attached to the manifold system are several smaller containers, either glass or stainless steel, into which the sample in the tube is to be transferred. The manifold system is evacuated and the vacuum break-off tip broken by an iron bar activated by a magnet. A section of solid at the bottom of the inverted tube is then melted and allowed to flow into one of the containers. After the desired amount is transferred to the container, the glass connection between the first container and the manifold is sealed. The first fraction removed is the purest and is labeled Fraction 1. This procedure is followed until all material in the zone-melting tube has been removed into several containers.

Some compounds have high vapor pressures at their melting points, and this may result in difficulties. For example, naphthalene has a vapor pressure of about 8 mm. of mercury at its melting point. As a result, a vapor space may separate the liquid and solid phases preventing establishment of equilibrium. The procedure for purification of this type of compounds is: First, heat the void space in the upper part of the tube to a temperature above the compound's melting point; then melt the top section of the solid, and finally freeze a thin plug of the compound at the top of the liquid before passing the heater down the tube.

Operating Variables in Zone Melting

Variables investigated were the number of heater passes, rate of heater travel and size of tubes. While results are reported on only one compound, they are typical of those found for quite a variety of substances.

Fig. 4 shows the effect of 1, 5 and 14 passes over ⅝ by 50-in. glass tubes containing 9-methylcarbazole. Each pass

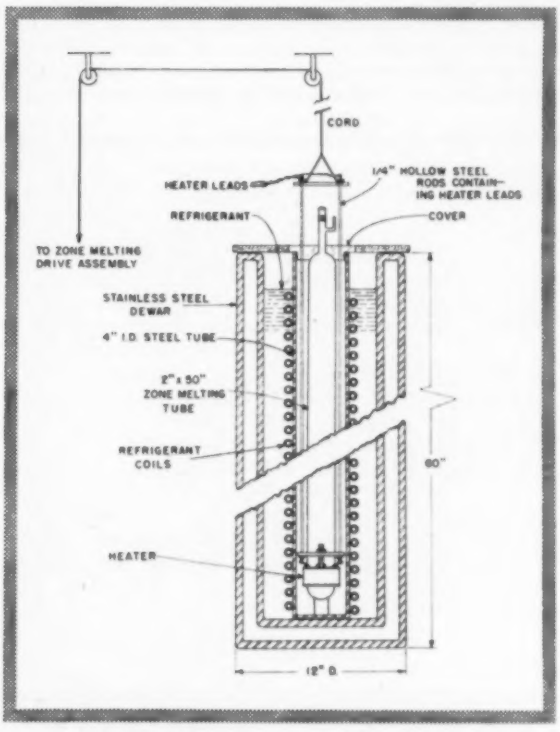

FIG. 3. Low-temperature zone melting equipment.

was made in 12 hours. The compound in each of the three tubes was divided into four fractions of approximately the same volume and purity of each fraction determined. Comparison of the first (top) fractions from three runs shows that the fraction subjected to the most passes is of highest purity. Fig. 4 also shows that impurities are moved down the column as more passes are made.

Effect of the rate at which passes are made is shown in Fig. 5. Two zone melting runs of 14 passes each were made on 1½ by 50-in. glass tubes containing 9-methylcarbazole. Time per pass for one tube was 12 hours and for the other, 50 hours. It can be seen from the chart that the slower rate gave the most purification. However, more passes of shorter time might be as effective as the 50-hour passes and still require less total time.

Effect of tube size is shown in Fig. 6. Here two runs were made on 9-methylcarbazole under similar conditions except that tube diameters were different. One of the glass tubes was ⅝ in. diameter while the other was 1½ in. diameter. Fourteen passes of 12 hours each were used. From the data in Fig. 6 the larger diameter tube appears to be more efficient.

Results for Purifying Nitrogen Compounds

Three examples of purification accomplished by zone melting will be given. Indole, 3-methylpyridine and 9-methylcarbazole were processed to purities higher than 99.9 mole percent. These purifications were accomplished using rather arbitrary conditions before any work was done on effect of changing operating variables. It appears that greater efficiency might have resulted from more passes at faster rates.

Indole. This compound, which melts at 52 C and boils at 254 C was purified using 20 passes of 50 hours each over a stainless steel tube 2 in. in diam by 50 in. long. The original material was a fine-grained, brown, crystalline substance having a purity of 99.5 mole percent. Preliminary zone-melting studies in glass tubes resulted in formation of colorless transparent crystals several inches long. But, excessive breakage of glass tubes was experienced.

This breakage was first attributed to expansion during melting, but later was found to be the result of adhesion of the solid to the glass. Glass tubes were thus discarded in favor of stainless steel tubes. Results of purification are indicated in Fig. 7, showing that half the material was recovered

About the authors . . .

John S. Ball is chief, Branch of Petroleum, Region III, for the U. S. Bureau of Mines, Laramie, Wyoming, where he directs petroleum research in the Rocky Mountain states. Ball received his BS in chemical engineering from Texas Technological College in 1934, and his MS in 1936. He also attended the University of Colorado. He joined the Bureau of Mines in 1938, and since then has worked in crude oil analysis, sulfur in petroleum, shale oil composition, and nitrogen compounds in petroleum. He is Director of API Research Projects 48 and 52.

C. R. Ferrin is a chemist working on the problem of nitrogen compounds in petroleum at the Laramie, Wyoming, station of the Bureau of Mines. Ferrin graduated from the University of Wyoming in 1955, with a BS in chemical engineering. He worked part-time at the Bureau while an undergraduate, and joined the Bureau for full-time work after graduation.

R. V. Helm is supervisor for API Research Project 52 on nitrogen compounds in petroleum at the Bureau of Mines, Laramie, Wyoming. Helm graduated from the University of Wyoming in 1944, with a BS in chemistry. Since joining the Bureau in 1945, he has worked on crude oil analysis, and sulfur and nitrogen compounds in petroleum.

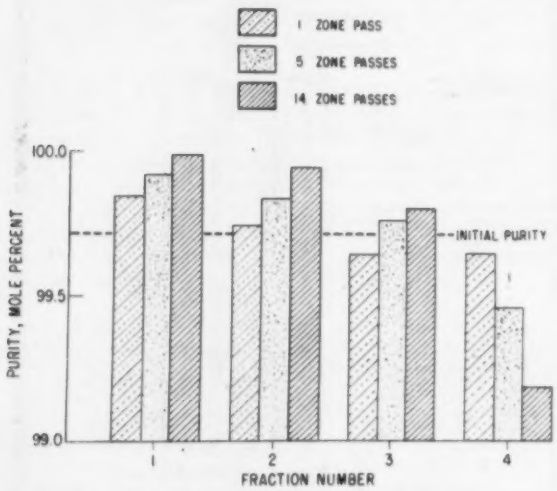

FIG. 4. Effect of the number of zone passes in purification of 9-methylcarbazole.

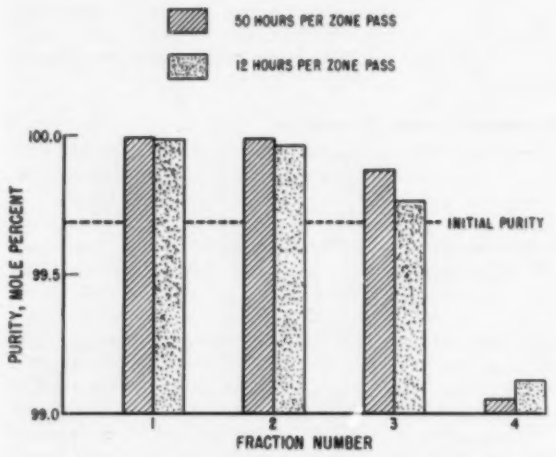

FIG. 5. Effect of time per zone pass in purification of 9-methylcarbazole.

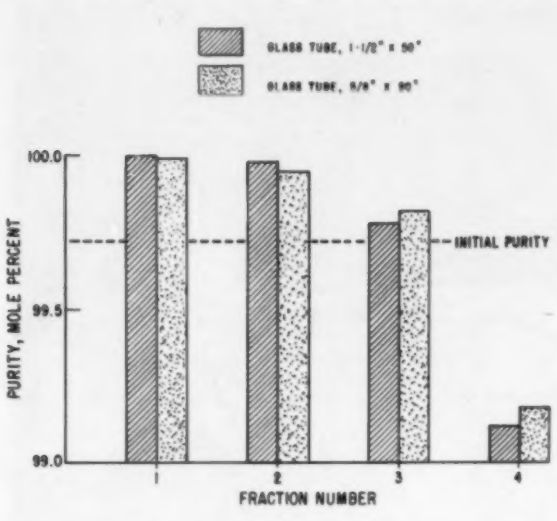

FIG. 6. Effect of tube size in zone purification of 9-methylcarbazole.

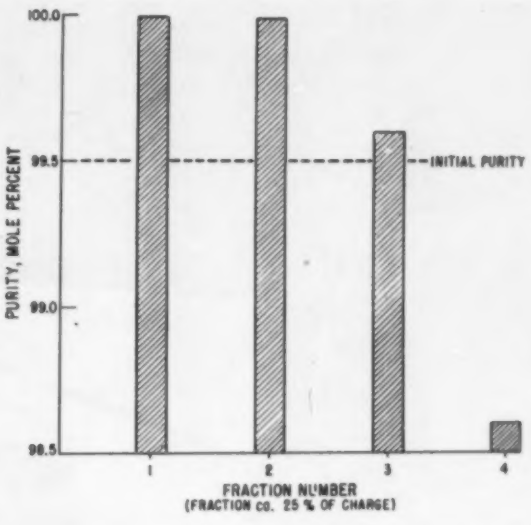

FIG. 7. Zone purification of indole.

at purities greater than 99.9 mole percent.

3-Methylpyridine. The starting material for zone melting purification had been distilled in a Stedman column (65 theoretical plates) and was 98.5 mole percent pure. As the freezing point of 3-methylpyridine is −18 C, a low-temperature zone-melting apparatus was used. After 8 zone passes of 12 hours each in a glass tube 1 by 50 in., the top 10 percent of the 3-methylpyridine had a purity of 99.9+ mole percent. Impurities in the starting material, as determined by infrared spectroscopy, were 4-methylpyridine and 2, 6-dimethylpyridine. These compounds boil very close to the 144.1 C boiling point of 3-methylpyridine. Consequently, purification by distillation would require complex azeotropic and extractive procedures whereas purification by zone melting is relatively simple.

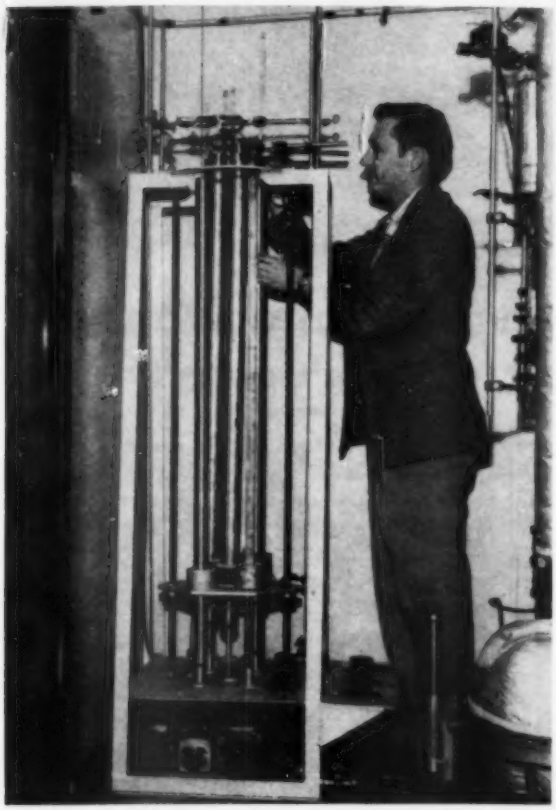

FIG. 8. Zone melting apparatus containing four stainless steel tubes and one glass tube. Co-author C. R. Ferrin is adjusting one of the tubes.

9-Methylcarbazole. The commercial material had a purity of 99.7 mole percent. Purification was accomplished by 14 passes of 50 hours duration each in a 2 by 50-in. stainless steel tube. As shown in Fig. 5 and 6, this purifies half the material to a purity higher than 99.9 mole percent. This compound melts at 89 C and boils with decomposition at approximately 310 C. It is thus impossible to purify it by ordinary distillation. Even vacuum distallation requires such a high temperature as to be impractical for efficient fractionation.

Evaluation of Zone Melting

Zone melting as an auxiliary purification process has advantages of simplicity, versatility, and efficiency. The nature of the impurity to be removed has little effect on the process in most instances.

Mechanically, the operation of zone melting can be accomplished in several ways. Movement of a heater along the tube has been described in the foregoing article. Other designs may move the tube through a heater, or by changing taps on a resistance winding extending the length of the tube, move the heated zone along a stationary tube.

Investigations now proceeding in various development laboratories indicate that zone melting or zone refining will soon be a tool for industrial use on organic compounds.

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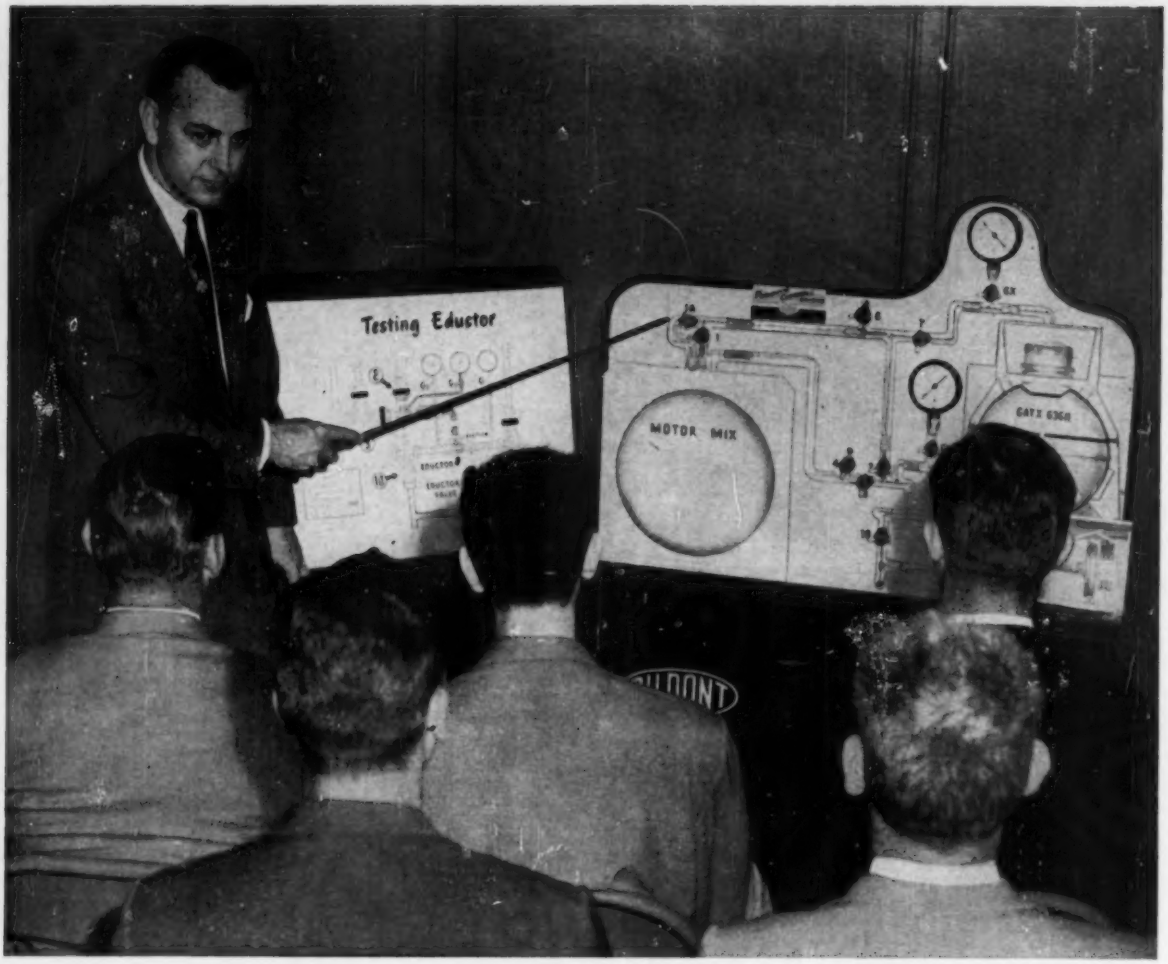

TYPICAL TRAINING SESSION conducted by Ron W. Beecher, Du Pont's Central Region Operations Coordinator, using scale-model blending plant to show safety procedures in unloading and weighing TEL from tank car.

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Refining Personals

▸ **John E. Wood III,** former general manager of the chemical products department of Esso Standard Oil Company, has been named president of Enjay Company, Inc. New Enjay vice presidents are **Karl J. Nelson, Harold J. Rose,** and **A. Donald Green.**

▸ **C. E. Wharton** of Tulsa, who retired last July from his position of vice president in charge of manufacturing for Warren Petroleum Corporation, has opened his own office as consulting engineer at 201 Enterprise Building, Tulsa. He will specialize in management and personnel problems, as well as act in an advisory capacity in construction and operating problems pertaining primarily to the natural gasoline industry.

▸ **David P. Martin** has been appointed chief engineer at the East Chicago, Indiana, refinery of Cities Service Oil Company. He succeeds **Walter V. Kaun,** who retired in November.

Cities Service Oil Company's new assistant superintendent of gasoline plant operations for District 1 is **Charles E. Powell** of Pampa, Texas. **Ed B. Lord,** superintendent of the West Seminole plant in Gaines County, Texas, will succeed Powell as superintendent of the Pampa plant. **Ben W. Mongomery,** superintendent of the East Chico plant in Wise County, Texas, is being transferred to West Seminole as plant superintendent.

▸ In the research and development department of The Atlantic Refining Company, **C. E. Headington** has been named manager of the basic research division and **W. K. Griesinger** named manager of the application research division.

▸ **Edwin F. Morello** has been appointed group leader at the Whiting research laboratories of Standard Oil Company (Indiana). Also at Whiting research laboratories, **Francis W. Porsche** is now a senior project chemist, **Bruce A. Ritzenthaler** has been named a group leader. **Richard A. Ahlbeck, William C. Taylor Jr., Frederick E. Mueller, William M. Herring Jr.,** and **Ralph G. Zelmer** have been appointed project chemical engineers. **Don E. Kennedy** is section leader in the research and development department at the Seymour, Indiana, laboratories.

▸ **Dr. John E. Kircher** has been promoted to executive assistant to the senior vice president at Continental Oil Company's Houston, Texas, offices. **E. R. Baker** succeeds Dr. Kircher as general manager of Conoco's petrochemical department in Houston. **Dr. M. L. Sharrah** is now manager of the research and development department at Ponca City, Oklahoma, succeeding Baker.

At Continental's Ponca City offices, **Dr. Warren L. Jensen** has been promoted to director of petrochemical research. **Warren W. Woods** succeeds Dr. Jensen as director of the petrochemical products research division.

▸ **Carl A. Setterstrom** has joined Sun Oil Company's research and development division to fill the newly-created position of assistant director of commercial development.

▸ **Dr. A. V. Grosse,** president of Temple University Research Institute in Philadelphia, Pennsylvania, has announced the appointment of **Dr. W. F. Faragher** as assistant to the president.

▸ **Ellis M. Frost Jr.** of Amarillo, Texas, who retired last year from the Bureau of Mines, received the Department of the Interior's Distinguished Service Award and Gold Medal for his "important contributions to the technology of helium production and use dating from 1926."

▸ **W. R. Sorenson** has been appointed superintendent of the chemicals division at The Texas Company's Port Arthur, Texas, works. He succeeds **M. F. Granville,** now general manager of Texaco's petrochemical department in New York. **Howard Wilson** takes Sorenson's place as assistant superintendent at Texaco's Eagle Point works in Westville, New Jersey. **W. K. Savage Jr.** has been transferred to New York from Port Arthur to replace Wilson as assistant supervisor of the refining department's process and production division.

▸ **Lee N. Haugen,** formerly vice president and general manager of Cit-Con Oil Corporation, has been elected vice president, general manager, and member of the board of directors of Cities Service Research & Development Company. Haugen succeeds Walter W. Scheumann, who died October 5.

▸ **F. E. Rosenstiehl** of The Texas Company was elected president of the National Lubricating Grease Institute at the Institute's 26th annual meeting in Chicago October 27-29. Other officers elected are **H. A. Mayor Jr.** of Southwest Grease and Oil, vice president; **Dr. J. V. Starr** of Esso Standard Oil, secretary; and **A. J. Daniel** of Battenfeld Grease and Oil, treasurer.

Elected to the NLGI board of directors: **S. C. M. Ambler** of British American Oil as Mayor, **T. W. Binford** of D-A Lubricants, **E. W. Campbell** of Gulf Oil, **R. Cubicciotti** of L. Sonneborn Sons, **A. G. Griswold** of Cities Service, **F. R. Hart** of Standard Oil (California), **C. L. Johnson** of Jesco Lubricants, **W. A. Magie II** of Magie Brothers Oil, **A. S. Randak** of Sinclair Refining, and **T. F. Shaffer** of Shell Oil.

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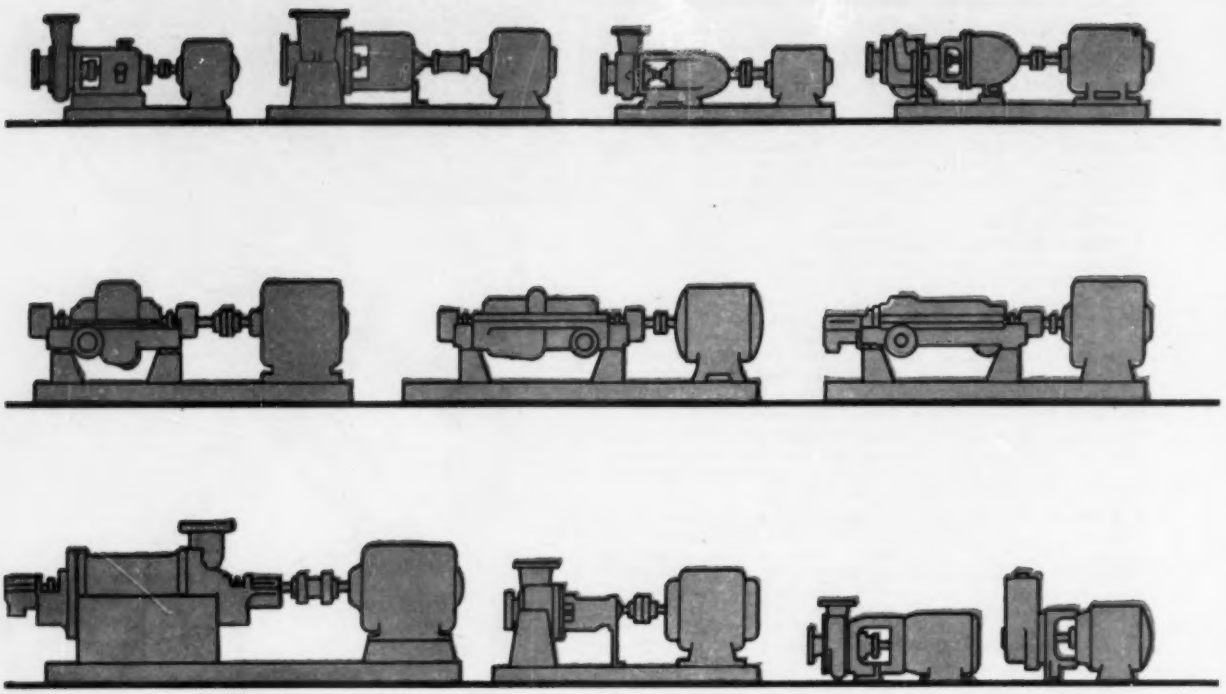

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2 *What if I need a "special" pump?*

Despite the unequalled completeness of the I-R line (a few of the hundreds of types and sizes are sketched above), there are occasions when a standard pump won't do the job properly. Here's where Ingersoll-Rand's long experience pays off. If the right pump doesn't exist, I-R will build it! This is another reason why you're always sure to get the right pump for the job from I-R.

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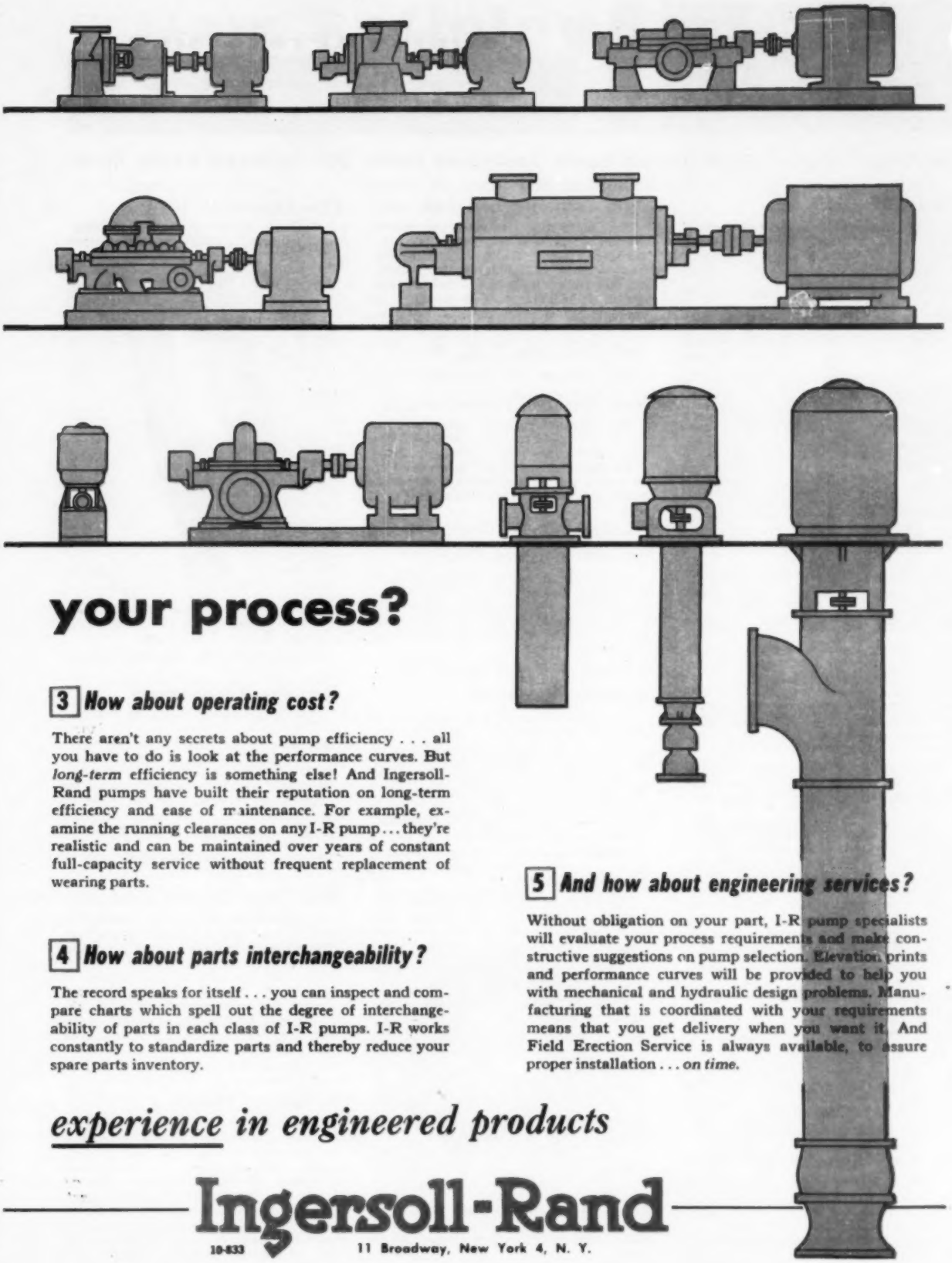

your process?

3 How about operating cost?

There aren't any secrets about pump efficiency . . . all you have to do is look at the performance curves. But *long-term* efficiency is something else! And Ingersoll-Rand pumps have built their reputation on long-term efficiency and ease of maintenance. For example, examine the running clearances on any I-R pump . . . they're realistic and can be maintained over years of constant full-capacity service without frequent replacement of wearing parts.

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The record speaks for itself . . . you can inspect and compare charts which spell out the degree of interchangeability of parts in each class of I-R pumps. I-R works constantly to standardize parts and thereby reduce your spare parts inventory.

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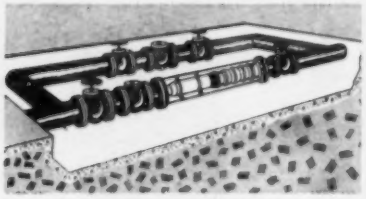
A new and complete line of sheet packings is now available. Further information is available from *Crane Packing Company.*

Circle number (41) on reply card.

Horizontal Pump

New submersible line booster pump is designed to operate in a horizontal position within the pipeline itself. New pump eliminates need for pump houses and is available in sizes for 8 to 24-in. pipe. *Layne & Bowler Pump Company.*



Circle number (42) on reply card.

Magnetic Pointer Flowmeter

A new line of flowmeters for high-pressure ranges use magnetically coupled pointers. Instruments are designed for operation in pressure range of 60 to 2000 psi. Meters for scale ranges up to 10 cfm and 20 gpm are available for direct installation into piping. *Seico Instruments Division of Eclipse.*

Circle number (43) on reply card.

Operations Digital Recorder

New digital device for production operations recording and data handling has been announced. The number of units produced during any preselected time interval may be readily interpreted visually from the tape record the recorder produces. The tape can also be used with automatic data processing machines. A cumulative production total is also presented. *Fischer & Porter Company.*

Circle number (44) on reply card.

Dialysis System for Acid Separation

New dialysis equipment separates acids and other chemicals from solution. Using acid-resistant membranes, the system recovery acids for re-use in processing that were heretofore discharged to waste. *Graver Water Conditioning Co.*

Circle number (45) on reply card.

Measure High-Pressure Fluids

New rotameters are designed to measure flow of hazardous and high-pressure fluids at temperatures up to 400 F. Information available on sizes, dimensions, capacities, sizing instructions from *Schutte and Koerting Company.*

Circle number (46) on reply card.

Data Gathering and Reduction

New pulse code data gathering and reduction system will measure and log the variables associated with the storage and transportation of liquids, by using standard sub-assemblies to form the complete system. It will handle such variables as liquid level, temperature, pressure, positive displacement meter readings, and other variables as required. *The Vapor Recovery Systems Company.*

Circle number (47) on reply card.

New Design Compressors

New adjustable stator blade variation for axial compressor range extension has been announced. This new design allows the capacity range of the compressor to be varied while the machine is in operation. *Allis-Chalmers Manufacturing Company.*

Circle number (48) on reply card.

Solvent Resistant Grease

A new grease highly resistant to most fluids and solvents is said to be impervious to the washing action of a wide range of petroleum, coal tar, and chlorinated liquids. *Pennsylvania Refining Company.*

Circle number (49) on reply card.

Portable Planimeter

New portable strip chart planimeter is especially designed for integrating records produced on 4-in. wide Fischer & Porter recorders. Both linear and square root totalization are available on same machine. Planimeter is accurate to ± 1 percent of full scale. 30-day chart roll is totalized without resetting the counter. *Fischer & Porter Company.*

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Finned Tubes

Finned tubes, which can increase heat transfer surface up to 10 times the bare tube area, now range in height from ¾ in. to 1¼ in. for new 6 in. I.P.S. size. Smallest tube — a pencil-size 3/16 in. is illustrated. *The Griscom-Russell Company.*

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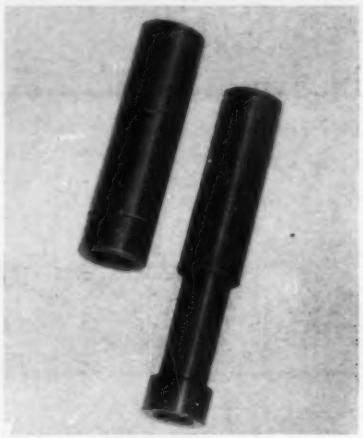
PVC Expansion Joint

New corrosion-resistant rigid polyvinyl chloride (PVC) expansion joint has a maximum traverse of 4 in. It remains fully guided even when completely extended. *Walworth Company.*



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Electronic Thermometer

New thermometer based on thermistors and designed specifically for industrial use is now available. The entire system was developed by a West German and has found wide acceptance in Europe. The small portable instrument measures temperatures between —60 and +845 F. Accuracy is ± 1 percent scale range and readability is 0.5 deg or better. *Atkins Technical, Inc.*

Circle number (53) on reply card.

New Trace Oxygen Analyzer

New accurate and sensitive analyzer is available in single or multiple ranges from 0 to 10 ppm to 0 to 1 percent oxygen. Instrument gives linear response over entire range. Accuracy is ± 2 percent at full scale for normal operations and ± 1 percent for short periods. Built-in calibrator cell permits the analyzer to be calibrated while onstream. *Analytic Systems Company.*

Circle number (54) on reply card.

Automatic Titrator

Automatic titrator, originally used for biomedical purposes, is now diversified for industrial research and routine processing. Instrument uses an amperometric end-point to obtain automatic shut-off at pre-set increment of indicator current. Can be used for all titration procedures, including oxidation-reduction, precipitation, acid-base, or complexiметric. *Laboratory Glass & Instruments Corp.*

Circle number (55) on reply card.

New Refining Literature

Heat Exchanger Design

New catalog describes complete line of heat exchangers, pressure vessels, and special process and power equipment which are designed, engineered, and manufactured for the process and power industries. *Southwestern Engineering Company.*

Circle number (64) on reply card.

Flowrator Meter Spec Sheet

Variable-area armored flowrator meter with metal tube and non-indicating electronic transmission for high-pressure applications up to 30,000 psi is described in new technical bulletin. *Fischer & Porter Company.*

Circle number (65) on reply card.

Pipe Selection Manual

This 16-page manual gives detailed information for selection and application of complete line of polyvinyl chloride pipe, tubing, and fittings. *Carlon Products Corporation.*

Circle number (66) on reply card.

Cryogenics Services Described

Low temperature processing, a key process tool, is a specialized science. This brochure describes applications of cryogenics and research and development services offered by *Air Products, Inc.*

Circle number (67) on reply card.

Organic Compound Catalog

New catalog of fatty acids and aliphatic organic compounds lists products previously unavailable on a commercial scale, revised specifications, and recently-developed application suggestions. Corrosion inhibitors, petroleum products additives are included. *Armour and Company, Chemical Division.*

Circle number (68) on reply card.

Glycol Technical Manual

A 40-page bulletin reviews completely physical and chemical properties and uses of ethylene glycol, diethylene glycol, triethylene glycol, and tetraethylene glycol. *Jefferson Chemical Company.*

Circle number (69) on reply card.

Corrosion-Proof Pipe and Fittings

New 4-page bulletin covers chemically inert, corrosion proof Teflon-lined pipe and fittings. *Resistoflex Corporation.*

Circle number (70) on reply card.

Acid Resistant Lab Equipment

New 20-page catalog lists polyethylene and nylon laboratory and industrial products which are not affected by concentrated acids, oxidizing agents, hydroxides, and polar liquids. *General Scientific Equipment Company.*

Circle number (71) on reply card.

Deaerating Heater Described

A 6-page bulletin contains information, including specifications and diagrams, about SSC Deaerating Heater. Unit is designed specifically for smaller plants for reduction of corrosion and pitting in boiler tubes, condensate return lines and accessories. *Graver Water Conditioning Company.*

Circle number (72) on reply card.

Centrifugal Pump Bulletin

Single stage double suction centrifugal pumps with horizontally split cases are described in new 16-page bulletin. Included are specifications, general descriptions, sectional views, construction details, mechanical and dimensional data. *Goulds Pumps, Inc.*

Circle number (73) on reply card.

New Plastic Piping Material

New 3-page engineering data bulletin deals with new plastic piping material which is offered in four pressure ratings. *Southwestern Plastic Pipe Company.*

Circle number (74) on reply card.

IBM Computer Program Library

Extensive library of computer programs to aid small oil refineries in the use of the IBM 650 computer for engineering purposes is now available. Most of the 10 programs contained in the package were developed by refinery engineers. Also available is brochure, "Proven Engineering Programs for Petroleum Refineries." *International Business Machines Corp.*

Circle number (75) on reply card.

New Illuminated Indicator

Pressure, draft, differential, and level are directly measured, indicated, and transmitted by a new multi-pointer gage unit. This 2-indicator unit is also furnished as a pneumatic receiver. Any number may be mounted on the same panel for multiple indications. Seven-inch indicating scales are available in red, green, blue, yellow, orange, and white. *Bailey Meter Company.*

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New Literature

Chemical Industry Brochure

A 40-page booklet, in full color, explains how National Distillers and Chemical Corporation invested in chemicals and grew in less than a decade to a leadership position in the chemical industry. *U. S. Industrial Chemicals Company, division of National Distillers and Chemical Corporation.*

Circle number (56) on reply card.

78-Page Systems Catalog

Systems to hold, power, and control cables and instrument piping are illustrated and fully described in new catalog. Diagrams, installation information, and load charts are included. *P-W Industries, Inc.*

Circle number (57) on reply card.

Petroleum Product Analysis

Improved method of determining acids and basic nitrogen compounds in petroleum products is described in paper now available. Included are use of titration with color indicators and use of nonaqueous titrations with visual indicators for oils too dark to be readily titrated by existing color indicator methods. *L. Sonneborn Sons, Inc.*

Circle number (58) on reply card.

Single Stage Centrifugals

New bulletin describes single stage centrifugal compressors for petrochemical and refinery applications. Two types are presented: One for low-pressure air service and one for gas applications plus high-pressure air. Capacities range from 1200 to 80,000 cu ft per min. Input horsepowers vary from 10 to 2500 brake hp. *Clark Brothers Co.*

Circle number (59) on reply card.

Gas Chromatography Data Sheet

Techniques for increasing quantitative accuracy in gas chromatography are described in detail in new data sheet. Advantages of the peak or integrated area measurement and peak height measurement methods are given. Several typical analyses show how each method is used. *Beckman/Scientific and Process Instruments Division.*

Circle number (60) on reply card.

Nitric Acid Brochure

Design and construction of nitric acid plants that assure low capital investment and low operating costs are described in new brochure. Operating details, flow diagrams, and information on engineering of plants to specific industrial requirements are included. *Girdler Construction Division of Chemetron Corporation.*

Circle number (61) on reply card.

Complete Instruments Catalog

A 52-page catalog and price list on process instruments includes indicators, transmitters, recorders and controllers. Instruments are available for quick shipment. *Fischer & Porter Company.*

Circle number (62) on reply card.

Control Valve Booklet

Illustrated 12-page bulletin gives details on construction and operating characteristics of complete line of control valves and optional accessories. Complete specifications and valve sizing data are included. *Conoflow Corporation.*

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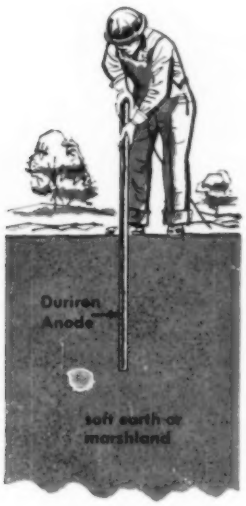
32 DURIRON® ANODES protect 11,000 feet of steel water line without backfill

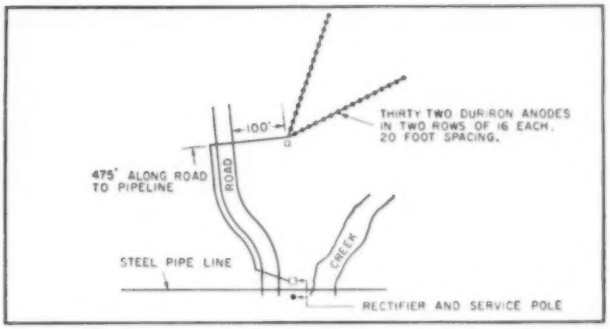
The Problem:

An isolated section of 11,000 feet of steel water line needed cathodic protection. Tests showed current requirements to be 40 amps., but replacement of adjacent wood stave lines called for extra capacity. Ground was a peat bog with water table standing at 6 inches below surface, making backfill methods impossible.

The Installation:



32 Duriron Anodes (2" x 60") were installed without backfill, by digging through the dry surface and then pushing anodes down until the tops were 3 feet below surface. Anodes were installed 20 feet apart, in two rows, with a calculated resistance of one ohm, based on previous experience with similar installations. While conventional backfill columns would have reduced the number of anodes necessary, the use of bare anodes constituted a major saving in cost.


100'
THIRTY TWO DURIRON ANODES IN TWO ROWS OF 16 EACH, 20 FOOT SPACING.
475' ALONG ROAD TO PIPELINE
ROAD
CREEK
STEEL PIPE LINE
RECTIFIER AND SERVICE POLE

The Performance:

The anode bed is discharging 60 amps. at a terminal voltage of 59 volts. The entire line section is under protection, the minimum potential being 1.18 volts. This affords ample margin to handle prospective additions to the line. Agreement between actual and calculated anode resistance is quite close.

Action:

For further information on this particular installation or for technical assistance on other Duriron impressed current anode installations, write:

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC. / DAYTON, OHIO

Foxboro Capacity Dynalog* Recorder, located upstream from receiving station, records dielectric constant of pipeline product — telemeters it ahead to delivery point.

New Accuracy in Interface Detection!

Unique Foxboro System profiles interface in advance — helps reduce product contamination at switch-over

Now your pipeline dispatchers can accurately chart the shape of an interface in advance — pinpoint their switch-over of product runs!

The Foxboro Pipeline Interface Detection System is based on the fact that even slight differences in grades of petroleum products have measurably different dielectric constants. Sensitive capacity Dynalog* Recorders measure this difference, both at the pipeline delivery station, and at a point one or two miles upstream. Foxboro Teletax* Telemetering brings the two measurements together on a single chart at the delivery station.

From the shape of the upstream record, the dispatcher selects the best cut point well before the interface arrives, and sets index at this point. When station interface record matches index, switch-over is made.

Foxboro Interface Detection eliminates sampling and guesswork — holds product contamination and loss to a new minimum. Systems in use today include both dual-measurement and single-measurement systems. Ask your nearby Foxboro Field Engineer about them, or write for Bulletin 20-11. **The Foxboro Company, 3812 Norfolk St., Foxboro, Massachusetts.**

*Reg. U.S. Pat. Off.

2-pen Capacity Dynalog Recorder, at delivery station. One pen records dielectric interface measurement telemetered from upstream station. Second pen records measurement at delivery station. From upstream record, dispatcher selects best cut point, and aligns index with this point on chart. When second pen matches index, switch-over takes place, either automatically or manually.

FOXBORO
REG. U.S. PAT. OFF.
INTERFACE DETECTION SYSTEMS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW MOTOROLA T-POWER 2-WAY RADIO

Transistorized Power Supply for both receiver and 25-watt transmitter

Long Life Transistors Replace the Vibrator . . .
Reduce Maintenance and "Down-Time"

Already famous for the lowest maintenance and operating costs in the 2-way mobile radio field, Motorola mobile radio is an even better investment now—with the T-POWER unit. The vibrator is gone! . . . replaced by rugged long-life transistors. Gone, too, is the problem of frequent vibrator replacement. Here is a mobile radio with an all-electronic power supply.

New Mounting Flexibility with Plug-In Control Head
. . . Same Basic Unit can be Used for Front or Trunk Mounting

With the T-POWER radio, you are no longer restricted to one type of mounting. Install the complete radio, with drawer unit and plug-in control head, for under-dash mounting. For rear mounting the same basic drawer unit can be installed in the trunk and connected by cable to a dash-mounted control head. And—the same basic drawer unit can be interchanged with the equivalent Motorola Twin-V trunk mount radio models operated from a 12-volt negative ground source.

T-POWER radio is another example of Motorola's continuing leadership in the practical application of transistors in mobile radio. Other tested and proved transistorized products include the Dynamic Microphone and Power Voice Speaker.

Get all the facts.—Write now for literature with complete information.

MOTOROLA Communications & Electronics, Inc. · 4501 Augusta Blvd., Chicago 51, Illinois · A Subsidiary of Motorola Inc.

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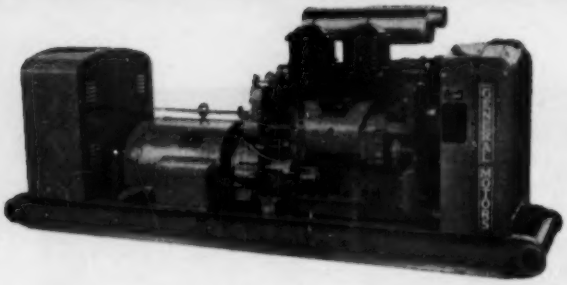

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CLOSED TYPE

From the world's most experienced producers of

ENGINE GENERATOR SETS

1500 Watts to 1000 Kilowatts

TRAILER MOUNTED

STEWART & STEVENSON

Stewart & Stevenson provides the most complete range of performance-proved engine generator sets. Combination Oil Field Utility Units, Rig Lighting Plants, A.C. Units, D.C. Units, heat exchanger cooled, radiator cooled, portable or stationary, explosion proof, standard type or custom built for any need.

Select the kind of power you prefer—Diesel, Natural Gas or LPG. Call, write or wire today for complete information on your engine generator set requirements.

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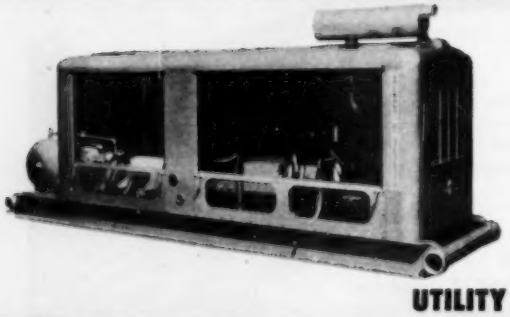
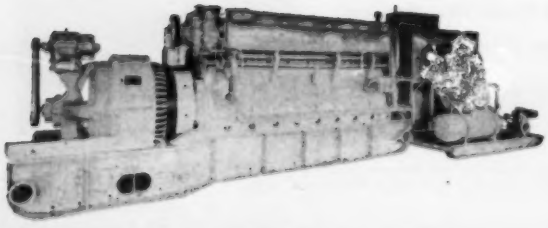
Main Office and Plant: 4516 Harrisburg Blvd.,
Phone CApitol 5-5341 Houston 11, Texas
Export: Room 1405, 74 Trinity Place, New York, N. Y.

THE WORLD'S LARGEST DISTRIBUTOR OF DIESEL ENGINES

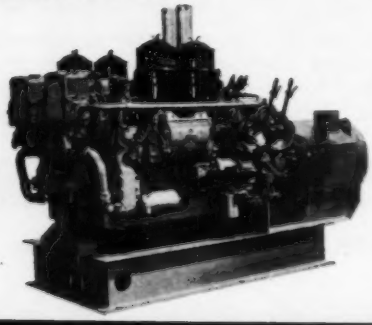


UTILITY UNIT

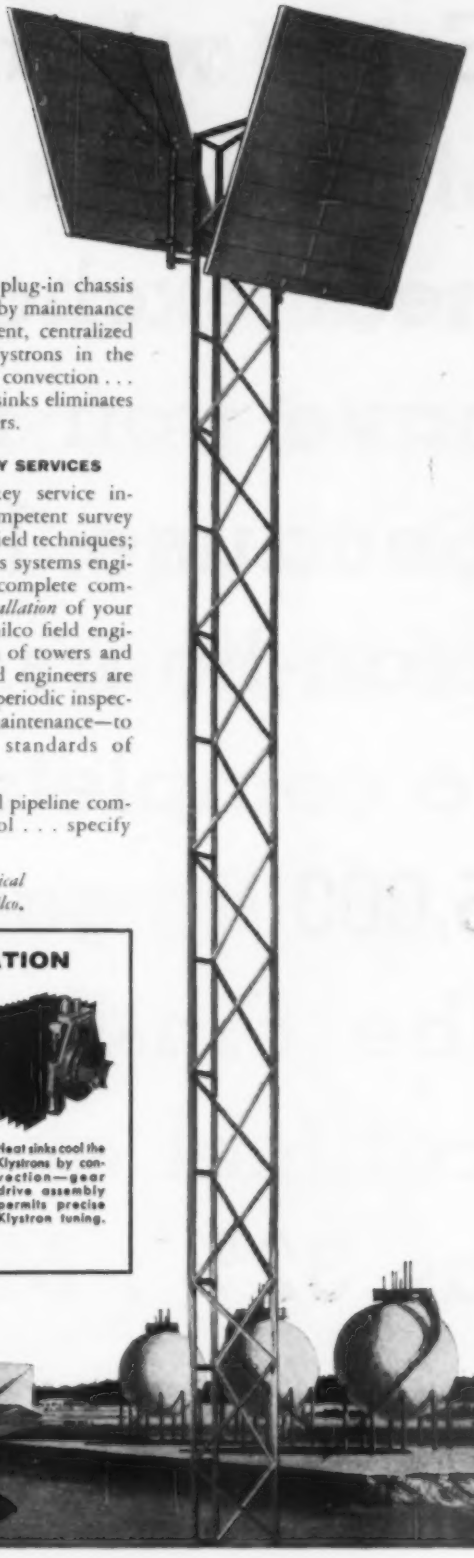
450 KW SKID MOUNTED



HEAT EXCHANGER TYPE



Reliable, unattended microwave operation for pipeline communications and control!



Philco CLR-9 microwave delivers outstanding system reliability, economy of installation and operation, simplified equipment maintenance for dependable pipeline communications. With 240 voice channel baseband capacity—for telephone, telemetering and remote control—and capability for handling high-speed computer data transmission—Philco microwave fills both immediate and long-range requirements of modern pipeliners.

Philco's new CLR-9 microwave equipment provides high channel density, duplex communications with integrated standby facilities for maximum system reliability. It is designed for quick installation in standard relay racks . . . and engineered with built-in metering and test facilities plus plug-in chassis for easy field maintenance.

Performance reliability is sharply increased in the new CLR-9 by the use of tubeless power supplies—new semiconductor rectifiers replace tubes. The use of printed wiring panels increases circuit stability—and complete plug-in chassis may be quickly removed by maintenance personnel (permits efficient, centralized depot maintenance). Klystrons in the new CLR-9 are cooled by convection . . . the use of compact heat sinks eliminates the need for bulky blowers.

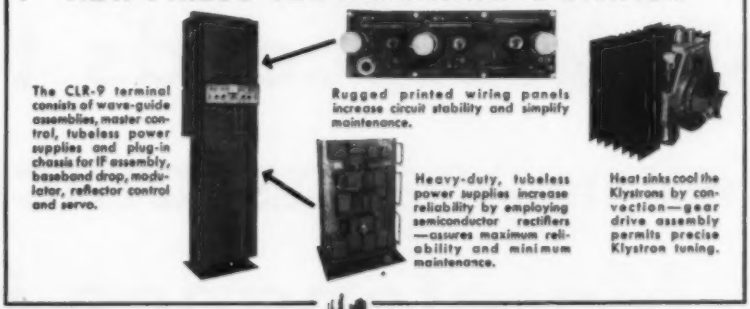
PLUS PHILCO'S TURNKEY SERVICES

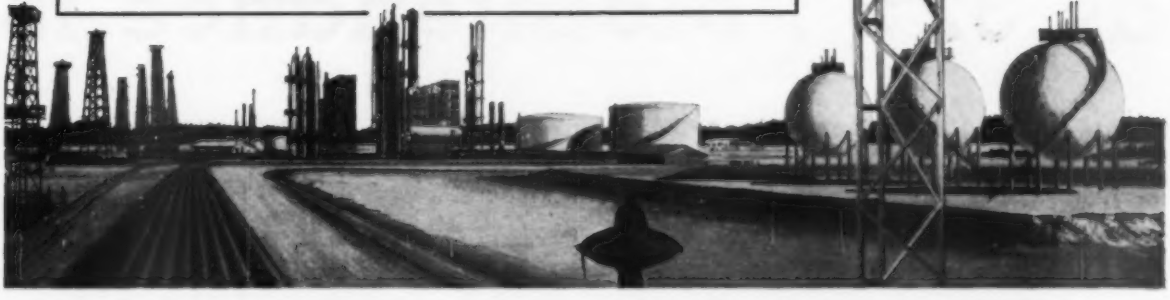
Philco's complete turnkey service includes—*site surveys* by competent survey engineers experienced in field techniques; *system planning* by Philco's systems engineers who design your complete communications system; *installation* of your microwave system by Philco field engineers—including erection of towers and shelters; and, Philco field engineers are available for *field service*—periodic inspection and preventive maintenance—to maintain the highest standards of system performance.

For reliable, unattended pipeline communications and control . . . specify Philco microwave.

At Philco, opportunities are unlimited in electronic and mechanical research and engineering • Look ahead . . . and you'll choose Philco.

NEW PHILCO CLR-9 MICROWAVE STATION


The CLR-9 terminal consists of wave-guide assemblies, master control, tubeless power supplies and plug-in chassis for IF assembly, baseband drop, modulator, reflector control and servo.
Rugged printed wiring panels increase circuit stability and simplify maintenance.
Heavy-duty, tubeless power supplies increase reliability by employing semiconductor rectifiers—assures maximum reliability and minimum maintenance.
Heat sinks cool the Klystrons by convection—gear drive assembly permits precise Klystron tuning.



PHILCO.

Government & Industrial Division

4718 Wissahickon Ave., Philadelphia 44, Pa.

In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

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Even when it's being installed, an APCO Fin-Pak heat exchanger starts to save you money. That's because less than 500 man-hours are necessary to complete the job (for a 5,000 hp gas turbine). Then the Fin-Pak proceeds to cut fuel expense as much as 32%*. Maintenance is nil. It even saves space—400 cubic feet in one installation instead of 1,050

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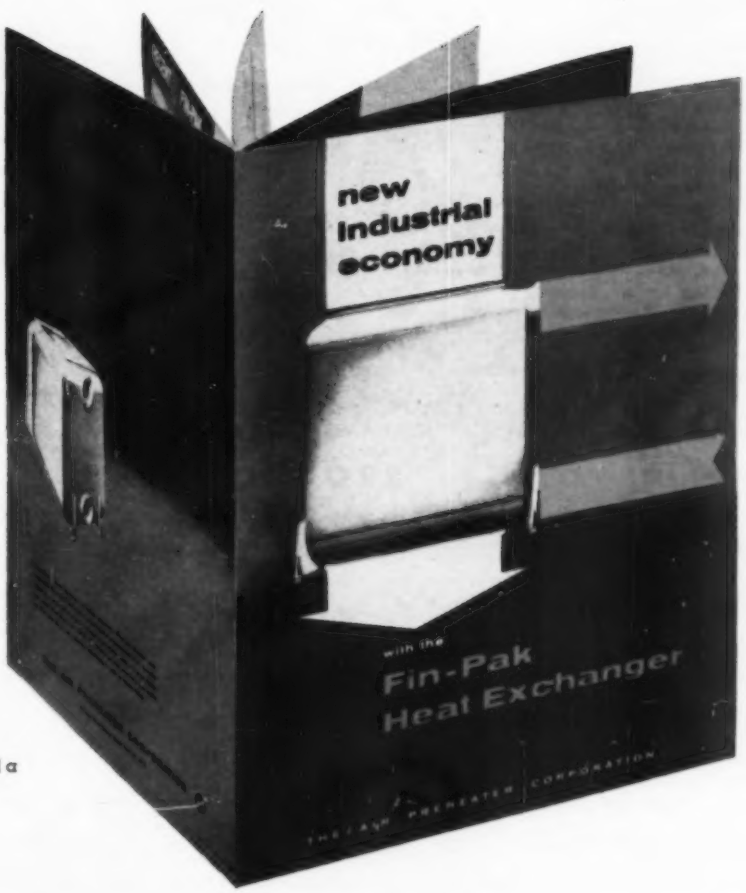
cubic feet for a tubular regenerator. If these facts suggest finding out more, get this new booklet from: Air Preheater Corp., 60 E. 42nd Street, New York, N.Y.



*At 1500 F, a 6-1 pressure ratio, and a designed effectiveness of 75%.

PIPELINE DEVELOPMENTS ★ ★ ★

Roundup of Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Act Oils Toronto, Ontario, Canada	450	—	Line from Peace River area in British Columbia, thru Pine Pass to Prince George, westward to Bella Coola terminus on Pacific Coast
Arabian American Oil Co. Dhahran, Saudi Arabia	164	30–32	Loops and extensions
Assam Oil Co. London, England	600	20	Upper Assam to Barauni
Bituminous Oil Pipeline Ltd. Calgary, Alberta, Canada	250	—	McMurray to Edmonton, Canada
Burmah Oil Co. Ltd. Glasgow, Scotland	250	20	Barauni to Calcutta
Cape Pipe Line Co. Philadelphia, Pennsylvania	200	—	Large diameter from Delaware Bay to Greater Philadelphia area refineries
C.R.E.P.S., Societe Nationale de Recherche et d'Exploitation des Petroles en Algerie and Cie. Francaise des Petroles des Algerie Paris, France	450	16	Edjele field, Algeria, to a Mediterranean Port on Libyan Coast
Elburz Oil Co.	1000	38	Qum, Iran, to Alexandretta, Turkey
Great Northern Railway Co. St. Paul, Minnesota	600	12–20	Williston Basin to St. Paul-Duluth-Superior, Wisconsin-Minnesota area
Independent Pipe Line Co. Calgary, Alberta, Canada	2019	34–36	Edmonton to Montreal
International Oil Pipeline Corp. New York, N. Y.	900	30	International boundary near North Gate, Saskatchewan, to Chicago area (continuation of Mid-Continental line)
Iraq Petroleum Co. London, England	Approx. 600	To 40 in.	Kirkuk field to Iskenderun, Turkey
Jayhawk Pipe Line Corp. Wichita, Kansas	140	6	Feeder lines to Interstate field, Morton County, Kansas, and Pleasant Prairie field, Haskell County.
Mid-Continent Pipelines Ltd. Edmonton, Alberta, Canada	600	30	Edmonton, Alberta, to U. S. boundary near North Gate, Saskatchewan
Royal Dutch-Shell The Hague, Netherlands	700	30	From the Mediterranean through eastern France, Luxembourg, West Germany, Netherlands, and Belgium to the North Sea
South European Pipeline Co. (Standard of New Jersey, Caltex, and numerous European companies)	930	30	Marseilles, France, to Hamburg, Germany
Union of Soviet Socialist Republics Moscow, Russia	2000	—	Baku field via the Ukraine and Poland to Oder River
West Coast Pipeline Co. Dallas, Texas	960	20–22	Wink, Texas, to Norwalk, California
Yacimientos Petroliferos Fiscales Buenos Aires, Argentina	390 620	14 12	Neuquen Province to Bahia Blanca Mendoza to San Lorenzo

PRODUCT LINES

Alaska-Yukon Pipe Lines Inc. Anchorage, Alaska	618	—	Valdez to Tok Junction, Alaska, and Kenai to Anchorage
American Pipe Line Co. New York, New York	1910	8–26	Beaumont, Texas, to Newark, New Jersey
Argentine Government (YPF) Buenos Aires, Argentina	650	10	Lujan de Cuyo refinery to Mendoza Province to Buenos Aires area
Hydrocarbons Pipeline, Ltd. Winnipeg, Manitoba, Canada	800	6–8	Edmonton, Alberta, to Fort William, Ontario
M. K. & T. and New York Central Railroads	2500	10	Houston-Kansas City-St. Louis-Indianapolis-Cleveland-Syracuse, New York, with branches to Chicago and Detroit
Northwest Pipeline Corp. Salt Lake City, Utah	350	8–10	Four Corners to Salt Lake City, Utah
Texas Eastern Transmission Corp. Shreveport, Louisiana	10 62	8 8	Lebanon, Ohio, to Todhunter Storage field Tyler to Carthage, Texas
Union Oil Company of California Los Angeles, California	815	—	Shale oil plant, Rifle, Colorado, to Los Angeles area

GAS LINES

Name of Company	Miles	Size	Location
Alberta Gas Trunk Line Ltd.	111.4	24	Cessford to Nevis
Calgary, Alberta, Canada	52	18	Nevis to Rimbey
	20	8	Duchess lateral
Alberta & Southern Transmission Co. (Pacific Gas & Electric) San Francisco, California	1390	36	High pressure gas line, Central Alberta, Canada, to San Francisco, California
Arkansas Industrial Pipeline Corp. (Subsidiary Arkansas Louisiana Gas Company) Shreveport, Louisiana	130	18	Perla, Hot Springs County, to Helena, Arkansas
Arkansas Louisiana Gas Co.	300	—	Main and gathering lines Louisiana-Texas Gulf Coast
Shreveport, Louisiana	105	18	Aetna field, near Clarksville, to Perla, Arkansas
Colorado Interstate Gas Co.	344	26, 30, 34	Four-Way station, Texas Panhandle, to Denver, Colorado
Colorado Springs, Colorado	148	34	Rock Springs, Wyoming, to Provo, Utah
Consumers Power Co.	40	24	Woodbury to Laingsburg Junction
Jackson, Michigan	120	26	Michigan-Indiana border to Plymouth, Michigan
Cuban Gas Transmission Co. (Edwin Pauley) Los Angeles, California	650	—	Mexico to Cuba
Edison Securities Company Los Angeles, California	130	—	San Joaquin Valley to Los Angeles
El Paso Natural Gas Co.	400	34	Salt Lake City, Utah, to California-Nevada border southwest of Las Vegas
El Paso, Texas	1000	—	Loops from Plains, Texas, to California border
Gulf Resources Inc. New York, N. Y.	125	—	Lines and gathering system from Lopena (Zapata County, Texas) area to point in La Salle County, Texas
Humble Oil and Refining Co. Houston, Texas	250	30	Southwest Texas (King Ranch) to connection with Clear Lake-Port Arthur line
Iron Ranges Natural Gas Co. St. Paul, Minnesota	133	6, 12, 16	Mesabi Iron Range to northern Minnesota
Midwestern Gas Transmission Co. Houston, Texas	2067	3–24	Main line from U. S.-Canadian border near Emerson, Manitoba — Noyes, Minnesota, to Portland, Tennessee. Laterals off main line to serve communities in Minnesota, North Dakota, and Wisconsin.
Northern Illinois Gas Co. Aurora, Illinois	140	24	Des Plaines to East Dubuque
Northern Natural Gas Co.	409	16–30	Additions to system, mostly loops
Omaha, Nebraska	73	20	Savanna Creek to Pincher Creek, Canada
	32	24	Pincher Creek to Montana border
Offshore Gathering Co. Houston, Texas	364	24, 26, 30	Gulf of Mexico from Sabine Pass to Mississippi River
Oklahoma-Missouri Gas Transmission Co. Oklahoma City, Oklahoma	500	24	New system extending from Bradley, Oklahoma, district to Rolla and Webster Groves, Missouri
Pacific Lighting Gas Supply Co. San Francisco, California	128	34	Needles to Newberry
Petroleos Mexicanos (Pamex)	130	22	Reynosa to Monterrey
Mexico City, Mexico	490	24	Jose Colomo field, Tabasco, to Mexico City
Southern California Gas Co. and Southern Counties Gas Co. Los Angeles, California	185	34	Ivanpah Lake to Placentia, California
Southern Natural Gas Co. Birmingham, Alabama	280	6–30	Loops and gathering lines
Sui Gas Transmission Company Multan, Punjab, India	130	10	Multan to Lyallpur, Pakistan
Tennessee Gas Transmission Co.	21	16	Offshore Louisiana
Houston, Texas	2	12	Offshore Louisiana
Texas Gas Transmission Corp.	92	30	Loops near Alexandria and Bastrop, Louisiana; Greenville and Clarksdale, Mississippi
Owensboro, Kentucky	19	26	Loops near Hardinsburg and West Point, Kentucky
	15	16 & less	Loops near Henderson, Kentucky; Petersburg and Linton, Indiana; Lawrenceville, Illinois
Texas Illinois Natural Gas Pipeline Co. Chicago, Illinois	860	30	Loops to system
Transcontinental Gas Pipe Line Corp. Houston, Texas	52	10, 14	Laterals in Texas and Louisiana
Transwestern Pipeline Co.	670	30	Mainline from Roswell, New Mexico, to Topock, Arizona
Houston, Texas	635	24	Two laterals from West Texas and Texas-Oklahoma Panhandle gas fields converging at Roswell
Trunkline Gas Co. Houston, Texas	691	4–30	New main line, loops, gathering
Yacimientos Petroliferos Fiscales Buenos Aires, Argentina	1305	26, 30	Comodoro Rivadavia field to Buenos Aires with lateral to Plaza Huincul

You're never stuck with a GROVE VALVE

Here's the valve you set and forget. Grove's exclusive Seal-O-Rings wipe out the need for valve lubrication. You're never stuck with valve failure because of forgotten lubricant or depleted sealing compound. The load of lubrication is gone forever. Specify Grove Seal-O-Ring Gate Valves. Under pressure the tightest seal in the line.

Grove valves never require lubrication

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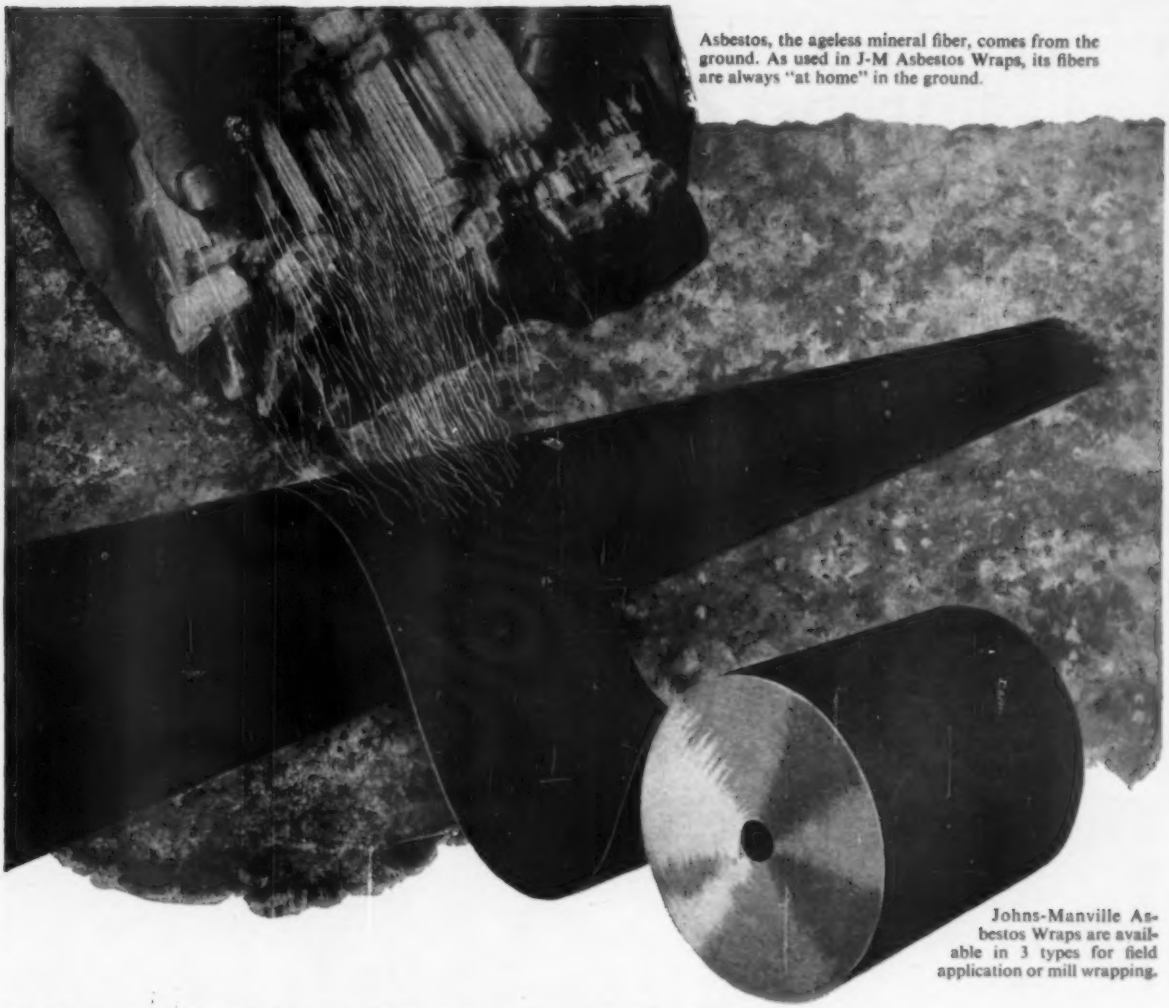
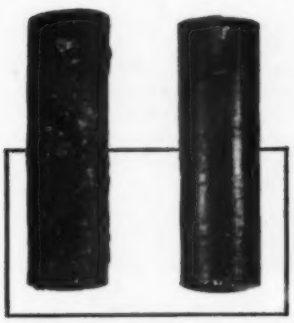


Asbestos, the ageless mineral fiber, comes from the ground. As used in J-M Asbestos Wraps, its fibers are always "at home" in the ground.

Johns-Manville Asbestos Wraps are available in 3 types for field application or mill wrapping.

LIKE WRAPPING YOUR PIPE ENAMELS IN STONE!

. . . J-M Asbestos Wraps
for tough, lasting protection



(Left) Plasticized enamel without J-M Asbestos Wrap did not stand up in soil stress tests. Coating had been applied to 18″ sections of 4″ O.D. pipe buried in bentonite clay which was then subjected to a series of wetting-downs and dryings.
(Right) Plasticized enamel with J-M Asbestos Wrap shows the full effectiveness of shielding action provided. Sample was in excellent condition after 28 wetting-drying cycles.

Obviously, pure stone can't be fabricated into sheet or roll form for pipeline enamel protection. But you can get the closest thing to it—J-M Asbestos Wrap, made of a lasting mineral fiber that's completely at home underground and uniquely conditioned by nature not to rot or decay.

In addition to being ageless, asbestos fibers are unusually strong and tough. As used in J-M Wraps, the fibers are felted, then impregnated with either coal tar or asphalt saturant to form, virtually, a flexible covering of stone. These "stone-like" qualities provide the durable shielding needed to protect enamels from earth loads, soil movement, other forces which weaken coatings and permit pipe corrosion to set in.

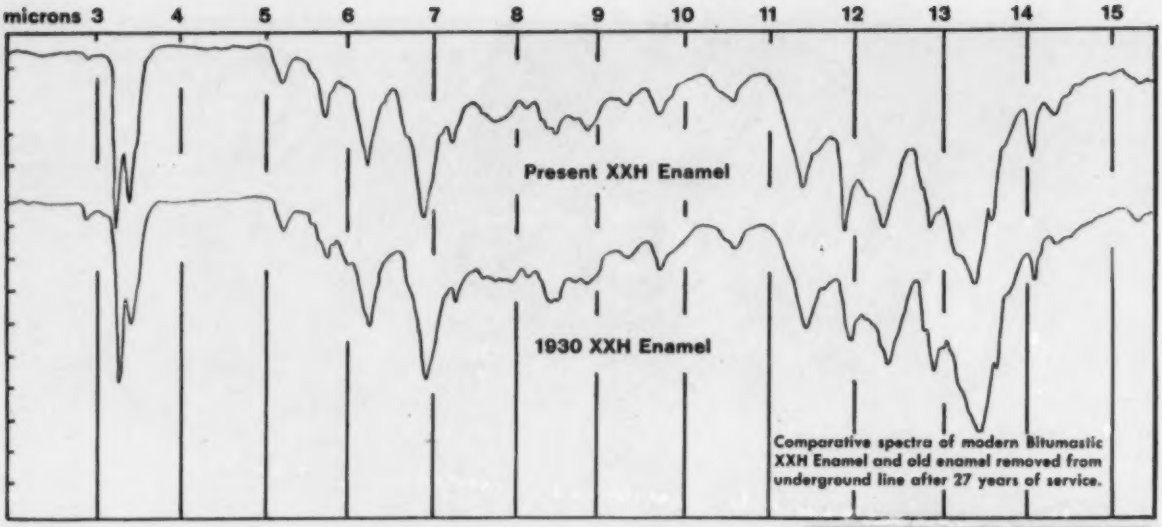
Extensive research and field tests conducted by a leading firm of consulting engineers have demonstrated these long-lasting protective values of J-M Wraps: "Asbestos Wraps offer the most effective single protection against damage—prolong the working life of pipeline enamels."

Pipeline engineers are invited to write for their own copy of this report PP-34A, a *3-Point Study of Pipeline Coatings and Wrappers*, at no cost or obligation.

Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario

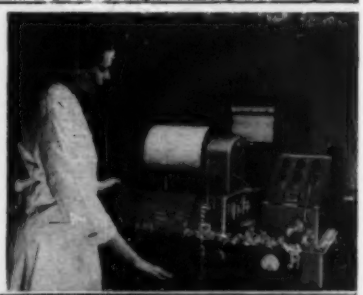
JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS



Comparative spectra of modern Bitumastic XXH Enamel and old enamel removed from underground line after 27 years of service.

Here's dramatic proof of modern coal-tar enamel's long-lasting corrosion protection



Natural Gas Pipeline Company of America recently relocated a portion of its line near Truro, Iowa which had been in continuous service for 27 years. Inspection of the pipe disclosed that it had been completely protected against corrosion by its Bitumastic XXH Enamel protective coating. In fact, the pipe—under minimum cathodic protection for only 2 of its 27-year life—was in such excellent condition that the firm planned to re-use this entire portion of the line.

A section of this old pipeline and its coating was brought to the Verona Research Laboratories of Koppers for testing and analysis. The 27-year-old enamel was subjected to standard ASTM tests for melting point, penetration, ash content and other physical characteristics. All the test results showed that the enamel had not been affected by its underground service and that it is identical to material being supplied today.

Finally, the infra-red absorption spectra shown above were obtained: note the close parallel between the old and new Bitumastic enamels throughout the spectrum. This similarity indicates that present-day Bitumastic enamel will give the same protection against corrosion underground as did the old enamel. Modern coal-tar enamel can be expected to *exceed* the 27-year record of the old coating, since today's application and inspection techniques are far better than those used in the '30s.

This proof-of-protection confirms again the superior waterproofing ability of coal-tar enamel that makes it the best investment for permanent protection of your pipeline. For further information, write or call Koppers Company, Inc., Tar Products Division, Pittsburgh 19, Pa. District Offices: Chicago, Los Angeles, New York, Boston, and Woodward (Birmingham), Ala. In Canada: Koppers Products Ltd., Toronto.

KOPPERS

BITUMASTIC

REG. U. S. PAT. OFF.

COATINGS AND ENAMELS

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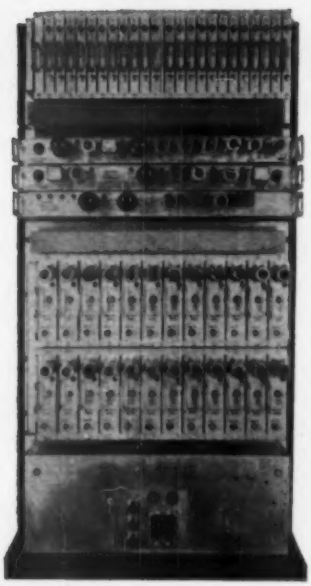
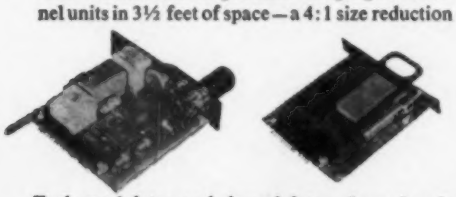
Kellogg Sets New Standards of Reliability in Microwave

Backed by the world-wide technical, manufacturing, installation and operating experience of ITT



New MICROPLEX provides 23 plug-in channel units in 3½ feet of space—a 4:1 size reduction



Each modulator and demodulator channel unit features printed circuitry.

Microwave was pioneered by ITT in 1931 with the Channel crossing from Calais to Dover. Today Kellogg Microwave is achieving new levels of reliability: 99.998%, far superior to wire line systems! Operating in dozens of installations throughout the world, Kellogg's *complete* communications package includes:

- *Microwave* — operating in the 2,000 and 10,000 megacycles bands.
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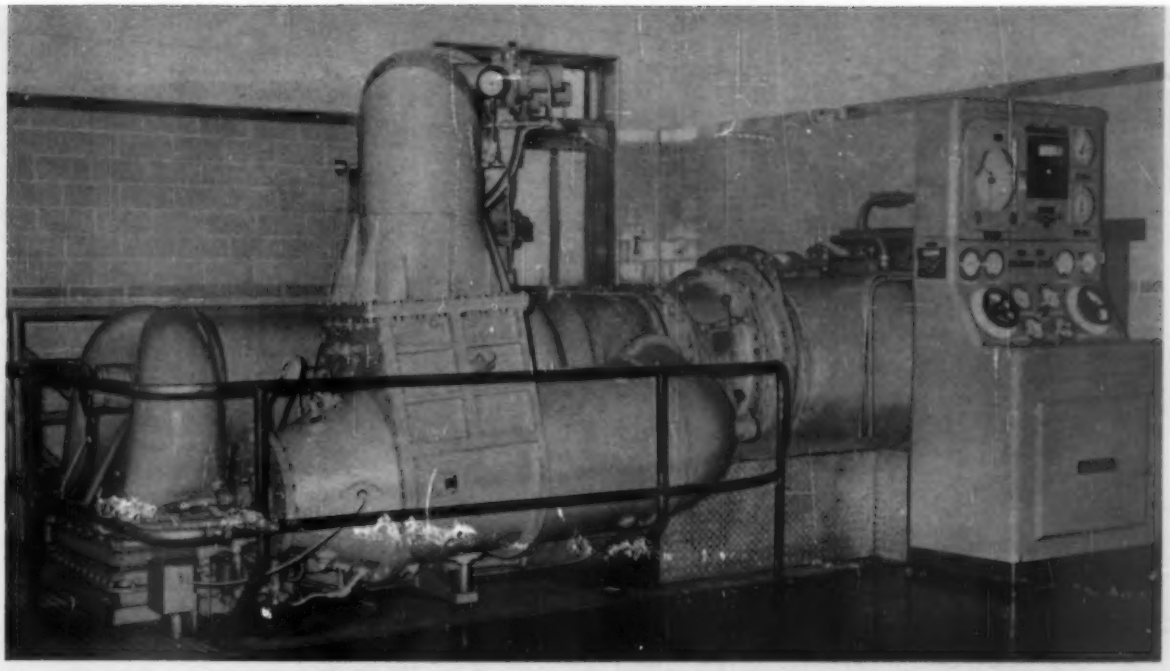


The turbine at the Great Lakes Pipe Line Company station at Tulsa is rated at 1150 hp at 80 F ambient temperature and at sea level. Changes in ambient temperature and elevation have a considerable effect on turbine output, the horsepower lowering approximately 4 percent for each 1000 ft rise in elevation and approximately 5 percent for each 10-deg rise in temperature.

Great Lakes first to use

P 616.

Gas Turbine to Pump Products

After nine-month test period, which saw several problems solved, turbine is running well and apparently is a success

Harold Hoyt
Chief Mechanical Engineer
Great Lakes Pipe Line Company
Kansas City, Missouri

MORE THAN A HUNDRED YEARS before the time of Christ a man named Hero stepped back in his little Alexandria workshop to view his handiwork. He had just made the first gas turbine. Hero's idea didn't catch on too quickly, however, because despite a developmental period of 2000 years, it has only been in the last three decades that the gas turbine has achieved commercial significance.

Within this period the gas turbine principle has been applied to such an extent to aircraft that jet planes rapidly are replacing the piston-type. Practical applications of gas turbines have been made in electric power plants, locomotives, gas compressors, ships, automobiles, and oil pipelines in foreign countries.

Now Great Lakes Pipe Line Company's gas turbine at its Tulsa pumping station—the first turbine installation on a products pipeline anywhere—may be proving the engine practical as a prime mover for products pipelines as well.

It has been about nine months since the unit was put into operation, powering a single-stage double-suction pump (designed especially for this installation) on a 34-mile 12-in. line from Tulsa to Barnsdall, Oklahoma. It is still too early for the full verdict to be in, but with most of the bugs believed ironed out, the turbine is running well and management seems pleased with it so far. The unit has pumped as much as 4200 bbl per hr.

Gas turbines, of course, have been used for a number of years by natural gas pipelines. They are ideal for that service, which requires large prime movers and has available a clean, economical fuel. Most of the turbines built in this country have ranged in size from 3000 to 20,000 hp with those of from 5000 to 7000 hp being quite common.

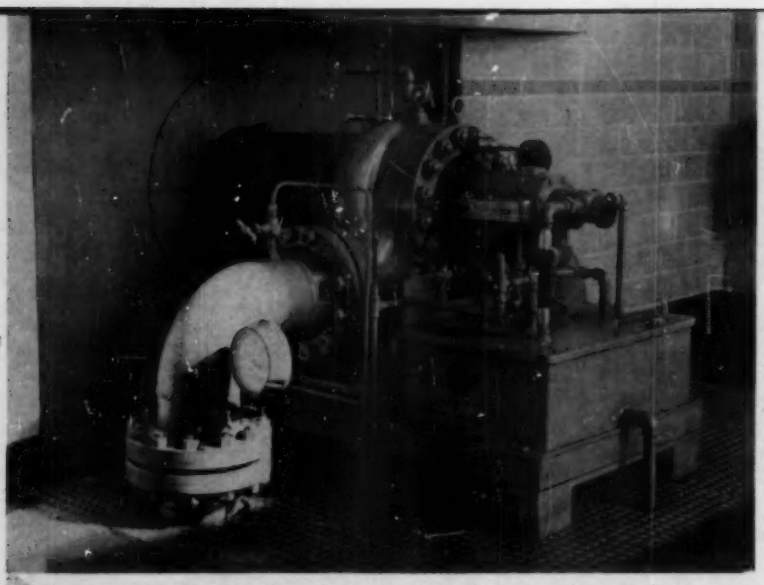
Products pipeline requirements, on the other hand, rarely have exceeded 2000 hp, with 1000 hp being a more common need. So, until the recent development of the 1150-hp turbine—the size Great Lakes has — gas turbines weren't practical for product pipeline use.

Three Basic Components to Turbine

All turbines consist of three basic components: An air compressor, a combustion chamber and a turbine. Basically, output is gained when air is drawn in and compressed, heated in the combustion chamber by burning a suitable fuel, and the resulting gases allowed to expand through a fan or turbine.

Since a products pipeline operation requires that the prime mover be operated at varying loads and speeds, the Great Lakes turbine is a two-shaft machine. The first turbine drives the compressor and the second turbine develops the usable power.

In the Great Lakes machine, a 13-stage compressor draws in 22 lb of air per sec (or 18,000 cu ft a min at sea level pressure, an amount that would fill a room 45 by 50 by 8 ft). This air



This pump was specially designed for the Great Lakes turbine. A single-stage, double-suction unit, it has a capacity of more than 4000 bbl per hr and develops 2000 ft of head. The pump proper measures only 48 in. long and 30 in. high, and the impeller is 12-3/16 in. in diameter.

is forced into the combustion chamber, where it is burned with natural gas, raising its temperature to approximately 1400 F and causing it to expand enormously. This expanding air and gas flows first through the high-pressure turbine, which drives the compressor, and next through the low-pressure turbine, which utilizes the energy remaining in the hot gases to drive the output shaft.

Startup Sequence

It takes two minutes from the time the turbine is started to reach its full load. The startup sequence, manually controlled, runs like this:

(1) The auxiliary lube oil pump is started.

(2) A battery starts the compressor and its turbine rotating.

(3) The compressor speed is built up and the unit is cleared of any residue gas accumulating during the shutdown period.

(4) A spark plug, similar to that used in an auto, ignites the gas pilot jet which in turn ignites the main jet stream.

(5) The compressor speed is built up to about 4500 rpm by which time the main fuel supply is in the combustion chamber and the compressor turbine becomes self supporting. Careful manipulation of the fuel supply is essential until the run position is reached.

(6) Control becomes automatic.

The compressor and its turbine can turn at 11,500 rpm and the power turbine has a 6400 rpm maximum. It has a high degree of flexibility in speed range and may be operated at a rate as low as 3200 rpm.

Although the unit is rated at 1150 hp, it has actually developed 1500 hp during cold weather. As the outside air temperature declines, the horsepower increases, the increase amounting to about 5 percent for each 10 degrees drop in temperature. Of course, the converse also is true: When the temperature rises, the horsepower is decreased. The altitude also plays a part. For every 1000 ft above sea level, the horsepower drops approximately 4 percent.

This temperature factor works out very well for products pipeline companies since the heaviest demands usually exist in the fall and winter because of heating oil shipments. Thus, the gas turbine can develop maximum output during the time that maximum output is required.

Advantages and Disadvantages

Besides flexibility, the gas turbine has several other advantages for products pipeliners: It is light weight, the total unit including pump weighing approximately seven tons, about a third as much as an 810-hp diesel. The turbine's components are readily accessible and wearing parts are few. The unit is air cooled, so no cooling water is required. Noise is somewhat less than in a comparable diesel unit. The turbine can easily be adapted to automatic operation.

There are disadvantages, too, and, as you would expect, the first operation of a turbine on the Great Lakes system uncovered several bugs.

The major and most obvious disadvantage is the low thermal efficiency rating of a turbine of the 1000 hp class, about 16 percent, compared to about 34 percent for a comparable diesel. The cost of getting 1000 hp, using natural gas as a fuel, has been about $3 per hr for the turbine compared with $2 per hr for a diesel engine with dual fuel burning equipment.

Since the air-gas mixture in the turbine reaches 1400 F and the exhaust temperature still is about 850 F, the cooling out time is long. It is sometimes necessary to keep the auxiliary lube oil pump running for eight hours after shutdown.

The duct work required is large and bulky, and the air filtering equipment needed is sizable and costly. Extensive air filtering is required because of the dust in the air, which, if not filtered out, can get on the compressor blading, drastically reducing efficiency.

In fact, the compressor blading must be kept almost white-glove clean. The Great Lakes turbine failed to develop full power a few months ago because of a light deposit on the blades. Now a regular weekly washing schedule, which consists of kerosine being injected into the inlet air stream to the compressor, has alleviated that problem.

Incidentally, ARAMCO, the crude oil pipeline in Arabia that uses similar turbines, is said not to have this problem even though its air filtering system is not as extensive as Great Lakes. There the sand in the air serves as a cleansing agent and blade washing is not required. Compressor blades show more wear, however.

These Problems Were Solved

Other troubles also plagued Great Lakes for a time. Originally the base structure developed objectionable resonant vibrations at high speed. This was corrected by stiffening the base with concrete.

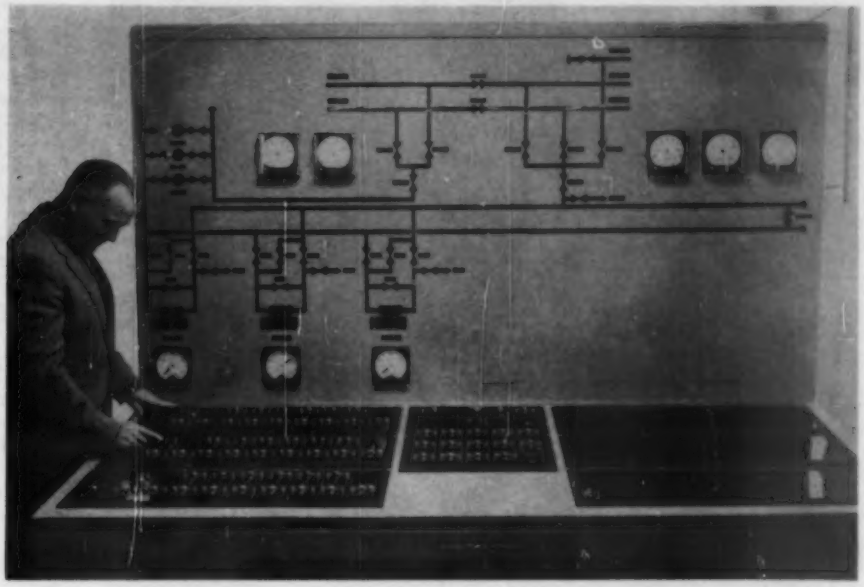
The critical speed of the shaft and coupling assembly between the pump and turbine turned out initially to be 5400 rpm, which was close to the operating range. A new shaft and coupling assembly was installed and the critical speed now is about 8400 rpm.

One of the most important changes made was one in design whereby practice start-ups could be made instead of the unit being connected only to the main line. Great Lakes operators naturally had no turbine experience, and it was found a training program for start-ups was necessary. If the machine is started too fast, say in 20 seconds or so, the turbine will get too hot. If more than a minute elapses before the gas is activated, the start-up battery will become discharged.

Such problems, of course, are expected in any new, untried venture. Great Lakes believes that most of the bugs now have been ironed out and that its experience with gas turbines has been and will continue to be extremely valuable. With the promise of higher efficiency gas turbines soon, the future of these continuous power flow engines appears bright for products pipelining.

* * *

P 624.



Console in station office at Lambertville, from which Linden station can be controlled. Leonard England, station chief, demonstrates the operation.

For first time . . .

Large Reciprocating Compressors are Operated Remotely

Texas Eastern constructs unattended station at Linden, New Jersey, to handle peak winter loads

Frank H. Love
Editor

TEXAS EASTERN Transmission Corporation has completed and will place in operation this winter a new type of compressor station. Remotely controlled, it will be the first instance of unattended operation of large-size reciprocating compressor engines in natural gas service.

The operating company is looking upon this installation as the initiation of a whole new field of operational techniques for the industry.

The station, which is situated at Linden, New Jersey, is the first of five such stations that will be built by the company within the next year.

Linden station has three 2050-hp reciprocating units at present, but provision has been made for the addition of three more when the need arises.

Only one attendant is assigned directly to Linden. A small maintenance crew works out of the station but is not directly a part of its operating personnel.

This satellite station is controlled from Lambertville, New Jersey, about 50 miles to the west. From that point an operator can start or stop Linden by the push of a button.

Electronic equipment records the information necessary for correct operation of the station and transmits it instantaneously to Lambertville. The information is recorded on a control panel by means of various colored lights, meters, and gages, and tells the operator at Lambertville whether all conditions are favorable to starting the controlled units. It tells him even such minute details as to whether the air inside the station building is dangerously contaminated with gas, or whether someone has entered the station as an unauthorized visitor. This, of course, in addition to knowledge that everything is in order mechanically for operation of the units.

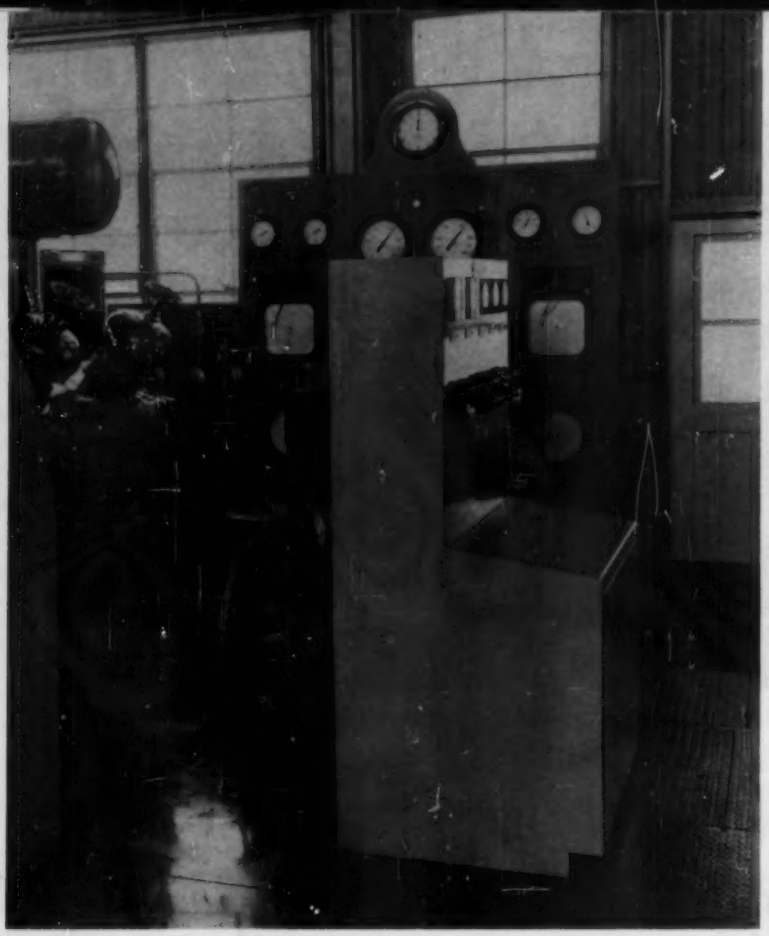
Control is over microwave or leased wireline, both of which are available. As this is its first remotely operated station, Texas Eastern is using both to gain operating knowledge on the efficiency of each.

The operator at Lambertville can control Linden from two points in his station: (1) The station office, or (2) the compressor building proper. The latter is the point from which the control usually is activated. The control in the station office is used to correct certain kinds of trouble should they occur. For example, cylinder pockets cannot be controlled from the compressor station floor.

Linden Station — Flexible and Reliable

As Linden will be used for load peaking, and so operated only during winter heavy load periods, volumes of gas pumped fluctuate more than for any other station on the system. It was designed, therefore, with two objectives in mind: Reliability and flexibility.

Automatic operation eliminates the factor of human error. An operator, for instance, might forget to close a certain valve when starting an engine. Result? The engine either wouldn't run or wouldn't continue to run. This can't happen at Linden because the electronic equipment follows a certain prescribed sequence to start and stop a compressor engine. If this sequence of events is interrupted in any instance the



Generally, Linden station is controlled from the panel shown in foreground, which is situated in the compressor building of Lambertville station, rather than from the console in the station office.

engine does not operate and the operator is notified of where the difficulty lies by means of lights, meters, and gages on the control panel.

An amazing array of electronic equipment is necessary in a station of this type. At Linden, main valves have gas-actuated operators equipped with limit switches. Gas pressure necessary to insure valve closure in case of line breaks is provided by a storage tank floating at line pressure.

Unit suction, discharge, and recycle valves are opened and closed in proper sequence by means of solenoid valves, which control the pressure to the gas operators. These solenoid valves, in turn, are operated by the electrical sequencing equipment. Pressurizing and vent valves are of the electric-open and spring-close type, and failure of electric power results in their closure.

Electric solenoid controls also regulate engine starting air, jet air, pockets, cylinder valves, fuel gas, etc. Automatic valve operators adjust cooling water valves, oil valves, and hydraulic oil valves. Such functions as dumping scrubbers, filling engine lubricators, and making up engine lubricating oil are performed automatically, and automatic motor-driven auxiliary lube oil pumps provide engine pre-lubrication.

The engine ignition system is independent of a-c power and has automatic spark control. The engine governor can be controlled remotely and has provisions for warm-up, run-back after shutdown, load control, etc. Cylinder valves and pockets for loading the engine are remotely controllable, and the fuel gas valve is operated automatically in conjunction with the governor.

A separate water cooling system is provided for each engine. Hydraulic pumps, driven off the units, power fin-fan coolers. Their speed is regulated by a temperature-controlled bypass valve. Requirements for cooling lube oil and jacket water are so closely matched that one three-way mixing valve can control the temperature of water entering the engine and the amount of water going through the lube oil cooler.

Detection devices on liquid levels, oil and gas pressures, oil, gas, and engine temperatures, etc., provide protection to the engine and station and indicate status of operation for control by the automatic sequence equipment. They also provide alarm, shutdown, lockout, or blowdown, as required. Specifically, these devices detect such conditions as crankcase explosion, engine overload, vibration, overspeed, high discharge gas pressure and temperature, engine rod and cylinder temperatures.

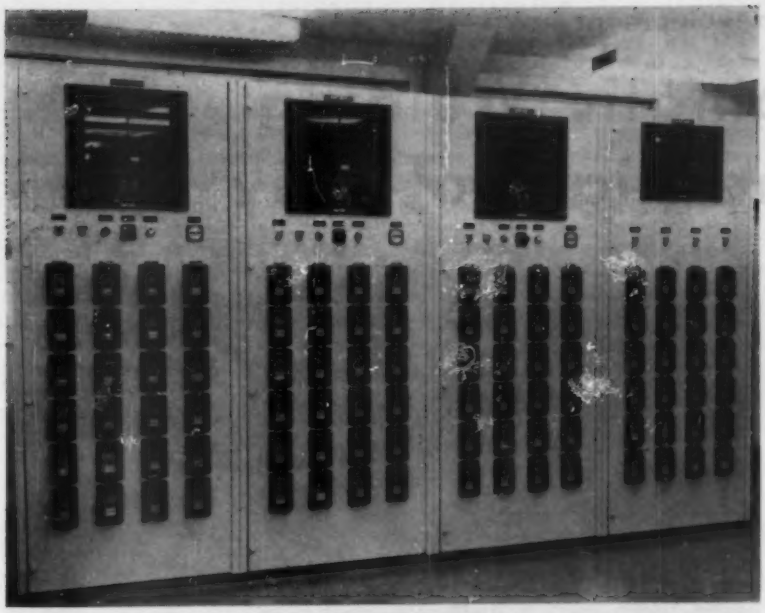
Detecting devices also are used to monitor valve positions, engine and station conditions, fire, explosive mixtures, unauthorized entry of personnel, and for many other purposes. Some of these methods are truly ingenious. A device detects the presence of combusted particles by the comparative ionization method, and so a fire is reported. Deposition of hydrocarbons on a heated element of another device raises the resistance of the element, which upsets a balanced bridge circuit to actuate a signal and inform of an explosive mixture. Illegal entry is detected by switches on each door, but authorized entry can be made without actuating an alarm by operating a bypass switch with a key.

Control Console

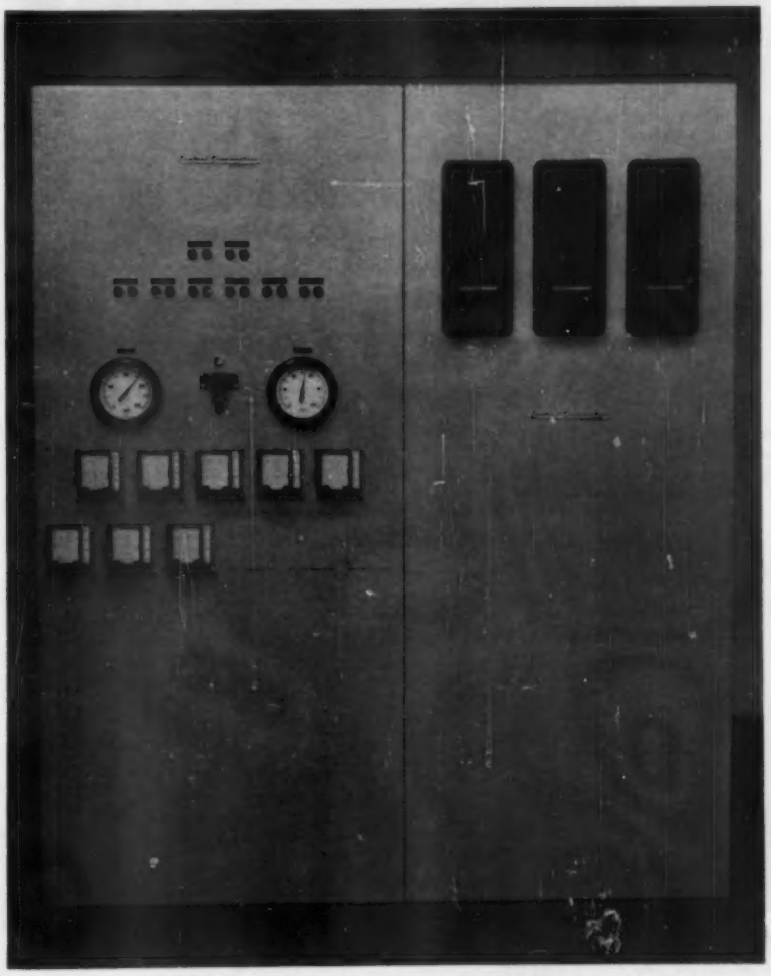
The control console at Lambertville at the present time has installed in it the station panel and three engine panels, with space provided for three additional engine panels. F. Vinton Long, chief of the communications section of Texas Eastern's engineering department, describes the operation of the console in this manner:

"Console lamps are controlled by the position of the relays in the nearby relay cabinet. These relays in turn are positioned to either the red or green position in accordance with one of two tones received during the scanning cycle. The change of any condition being monitored by the supervisory equipment of Linden station (station being controlled) initiates a scanning cycle consisting of a rotating switch in which the arm of the switch touches a series of contacts in sequence, one at a time. In this manner each of the alarms takes its turn in transmitting a red lamp or green lamp condition to Lambertville. During the time the wiping arm is on a particular contact, either a tone corresponding to the red lamp condition is transmitted to Lambertville or another tone that corresponds to the green lamp condition is transmitted, depending on whether the monitor relay in the supervisory equipment is energized.

"During the time the scanner or distributor at Linden is in a scanning cycle, a similar distributor at Lambertville is stepped from relay to relay in synchronization with the distributor at Linden. In this manner only two tones or two sub-channels are used to time-multiplex the transmission of alarms, permitting the position of more than 90 alarms to be indicated over the com-



Automatic control panels at Linden. Cubicle on right is station control panel. The other three cubicles are controls for units No. 1, 2, and 3.



Linden station instrument panel (left) and supervisory and telemetering panel (right).

munication channel within the 18-second period of one scanning cycle."

Starting the Engine

Before starting an engine the green lamp on the console should be lighted, of course, because this shows that the engine is in the stop position. The amber light also should be lighted, as it shows that all conditions permissive to starting have been fulfilled and the engine is operable.

The key switch is now placed at the *start* position, and, simultaneously, the *operate* switch is positioned, the two switches being held in position until the blue lamp lights. This indicates the signal has been received at Linden and the master sequence starting relays energized. Both switches are now released.

As the starting sequence gets underway, a distributor cycle is started and the amber light is turned off. As the engine begins cranking and comes up to speed of 50 to 75 rpm, another distributor cycle is started and the green light is turned off. From this point until the engine is warmed up and ready to load, only the blue lamp burns, indicating the engine is still in sequence. As speed begins to increase, however, the tachometer, at the back of the console panel, gives an indication.

After the engine is warmed up, and suction and discharge valves are open and all other valves closed, another distributor cycle starts. Then, the blue lamp is extinguished and a red light goes on, indicating that the engine is ready to load.

The engine is stopped in a like manner: The start-stop switch is placed in the *stop* position and held while the *operate* switch is positioned. The two are held in position until a white light indicates that the signal has been received by Linden. After the engine has stopped, distributor cycles restore the lamps to indicate a stopped condition.

Four More Automatic Stations Planned

Knowledge gained from the Linden-Lambertville operation will aid Texas Eastern personnel in their installation of four more remotely operated stations on the Penn-Jersey system, which extends from a point near Pittsburgh across central Pennsylvania to Lambertville where it connects with Texas Eastern's main line. This line is especially important during winter because it carries large volumes of gas from underground storage to market areas to supply peak demands. The company operates one of the larger underground storage fields, Oakford Storage, just east of Pittsburgh, and has another field in central Pennsylvania soon to be developed. ★ ★ ★

P 615.322.2

Dr. Hans Gunther's new development holds promise for . . .

Automatic Welding on the Right-of-Way

Donald M. Taylor

MANY have been the dreams of an automatic welding machine that will ply down the right-of-way, pausing a brief instant at each joint of pipe to produce a flawless weld — which in turn will produce a flawless X-ray to gladden the company inspector. Most vivid of such dreams likely emanate from the pillows of pipeline contractors who habitually occupy the role of runner-up, or second best, in dealings with the tempestuous and unpredictable gentlemen of the white cap, hood, and low quarter boots — the pipeline welders!

Now, out of West Germany comes a new welding process that may reverse the status of power and the pecking order on the pipeline. The process is fully automatic, requiring no manual assistance in the way of tack welds, stringers, etc.

When Earl Allen, Houston, Texas, pipeline contractor, imported the machine into this country and set up a demonstration in the Crutcher-Rolfs-Cummings, Inc., yard recently, pipeliners traveled from distant points to witness the process in operation. Many of them expressed approval of the machine; others felt it needed more development work and testing before "breaking-out" on the right-of-way. Almost all voiced approval of the quality of the welds.

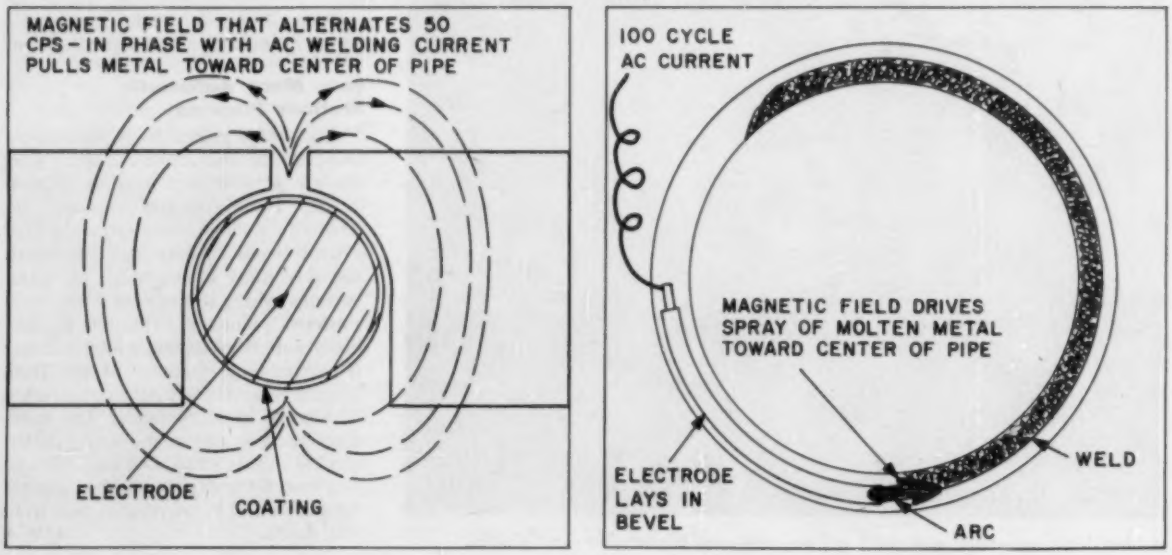
Welding machine is tractor-mounted. Engine turns the tractor wheels as well as powering two generators.

The inventor of this equipment is Dr. Hans Gunther of Heidelberg, Germany, and the principle he employed to overcome the chief difficulty that has stood athwart the development of an automatic welder for the pipeline is childishly simple, though somewhat complex in application.

Automatic welding is not new. It is used in shipbuilding, manufacturing of pipe, and in other industries. The reason it has yet to make an appearance on the pipeline for "firing line" application is that no one -- until now -- was able to solve the problem of welding the underside of the pipe. The upside down position causes weld metal to run out of the bevel. Nothing less than the deft movement of a highly skilled welder could cause the weld metal to penetrate, adhere, and freeze in the 4:00 to 8:00 o'clock positions on the pipe.

How does this process work? The

How underside of pipe is welded


MAGNETIC FIELD THAT ALTERNATES 50 CPS – IN PHASE WITH AC WELDING CURRENT PULLS METAL TOWARD CENTER OF PIPE
ELECTRODE
COATING
100 CYCLE AC CURRENT
MAGNETIC FIELD DRIVES SPRAY OF MOLTEN METAL TOWARD CENTER OF PIPE
ELECTRODE LAYS IN BEVEL
WELD
ARC

ingenious solution devised by Dr. Gunther was to use a magnetic field to direct the metal spray from the arc and weld puddle toward the center of the pipe regardless of its position on the pipe. He does this with an electromagnetic "girdle" or belt. Another problem —that of directing the traverse of the electrode about the pipe was solved by simply curving the coated electrode and laying it flat in the bevel. Thus, the arc leaves the electrode tangentially, and the magnetic field bends it toward the center of the pipe. The weld puddle is held in place by magnetic forces rather than by gravity until it freezes.

Step-by-step. Before we go into the finer points of the process, let's take a look at the procedure of making a weld by this method. *First*, the pipe is beveled, preferably in a U-shaped bevel slightly larger than the diameter of the rod. *Second*, the pipe is lined up with external line-up clamps. *Third*, the welding rod is bent in a segment of a circle having a radius equal to that of the pipe. *Fourth*, a magnetic "girdle" or belt is slipped under the clamps and over the rod lying in the bevel. *Fifth*, the magnetic coil is energized and welding current impressed on the rod. *Sixth*, the rod is shorted out to the pipe with an ice pick or other metal conductor to start the arc. *Seventh*, the rod burns almost to the end and the equipment shuts off. The weld is cleaned, and the process repeated until the weld is completed.

The welding machine and magnetic field are a-c. Moreover, the welding current and the magnetic field are in phase with one another—driven by the same engine.

The magnetic belt that circles a segment of the pipe is the key piece of welding equipment. This belt is composed of a series of electromagnets powered by a 5-kva, 3-phase generator driven off a second shaft on the main engine. The magnets are linked in a flexible belt about 20 in. long.

Welding machine. The welding machine is tractor mounted, and the engine turns the tractor wheels as well as driving two generators. The engine is rated at 18 hp and it powers a 15-kva single-phase a-c welding generator that produces a current of 400 v, 100 cps. The second generator, which provides a source of current for the magnetic belt, grinding tools, etc., is rated at 5 kva, 380 v, 50 cps.

Bevels. Although the process has proved adequate to weld 5/16-in. wall pipe with ordinary 30-deg bevels, U-bevels slightly larger than the rods to be used are best. At present they are ground with German equipment.

Line-up. The line-up must be very accurate. On the first pass, there is no stringer bead filling the lower portion of the bevel and excessive gaps can produce windows—especially in the upper quadrants where the force of gravity is additive with the magnetic field. External line-up clamps were used in demonstrations carried out in Houston; however, Dr. Gunther says his company has electrically operated internal line-up clamps that produce superior line-up.

Electrodes. The electrodes are designed for a-c current. It is very important that the cellulose coating be mechanically and diaelectrically strong, because otherwise the arc may short out the side of the rod, rather than burning off the end.

Burn-off rate. The burn-off rate is approximately equal to that of a manual weld. One of the differences, however, is that the rod is consumed almost to the end. As a rule the machine shuts off automatically when the rod is about one inch long.

How many passes? The number of passes is about the same as for conventional downhill welding. On ⅜-in. pipe four or five passes are used; ½-in. requires seven passes.

Multiple passes. One of the advantages of the process are that as many as four welds can be made simultaneously on large diameter pipe if four magnetic belts are hooked around the pipe.

Why not use longer belts, longer rods? This would be a good idea except that longer belts would require extra help in handling because of weight. The trouble with longer rods is that any electrode in excess of conventional length tends to overheat and scorch its coating.

Overlaps. To make a continuous weld, each welding rod must overlap the previous weld. The result is that there is a definite build-up of weld metal in the overlap area. This surplus metal must be ground out.

Grinding machine. The most novel feature of the equipment is the grinding machine. This light electric grinder uses nylon disks that will last for more than 20 hours of continuous operation. The motor turns at 8000 rpm.

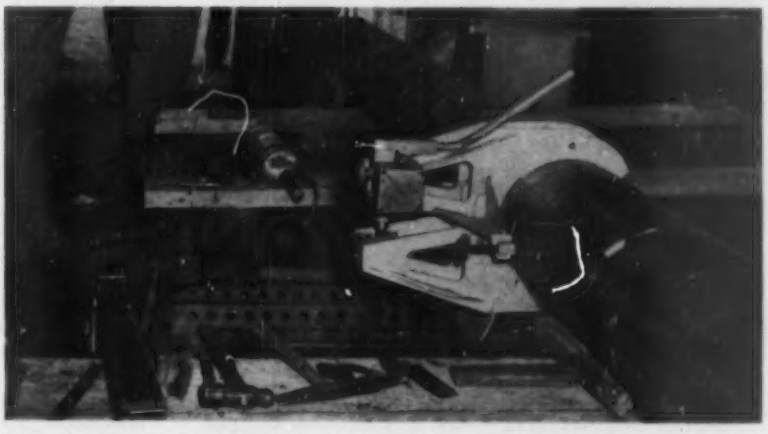
Magnetic belt, which circles a segment of the pipe, is the key piece of welding equipment.

How long will equipment last? Dr. Gunther says the magnetic belt should be good for 10,000 welds—however, it must be brush cleaned after every weld.

Experience. The welds the process produces are equal to or better than those produced manually. The equipment has been used to weld API X52 pipe satisfactorily, and in Germany it has been used to weld 8, 12 and 26-in. pipe in the field, Dr. Gunther reports.

The concensus expressed by pipeliners who witnessed the demonstration of the process in Houston, was that the welds seemingly were good, and the process definitely has merit. As for the $64 question, "How will it do on the right-of-way?", they are waiting to see.

* * *



Clamp for lining-up pipe. Line-up must be extremely accurate, as there is no stringer bead filling the lower portion of the bevel and excessive gaps could produce windows.

THE PIPELINE ENGINEER interviews GEORGE W. PETTENGILL, Communications Products Department, Radio Corporation of America, about how manufacturers are planning equipment to meet new FCC rule to provide additional mobile radio service through...

SPLIT CHANNEL OPERATION

George W. Pettengill

What is the FCC doing to provide more channels for mobile radio users?

During the year 1957, and thus far in 1958, the Federal Communications Commission has been very active in making rule changes and proposing further changes that affect all users in the land mobile radio services. To obtain complete information on these changes and proposals, the information issued by the FCC should be studied carefully; however, the major points may be of interest to you.

The rule changes in general concern themselves with allocating more channels in the present bands in order to make it possible for more people to use mobile radio communication. This is the so-called "split channel" ruling. The proposed rule changes also concern themselves with setting up several new classes of radio services to better fit the prospective users of mobile radio communication.

How will this affect users in the various bands?

In the 30-50-mc band the channels, for several years, have been set up on the basis of 40-kc spacing. The rules now set them up on the basis of 20-kc spacing so that there are approximately twice as many available. All new channels made available have been allocated or reserved for a particular service.

In the 152-162-mc band the channels were set up on the basis of 60-kc spacing. The rules now set them up on the basis of 15 kc but will use them on the basis of every other channel or every 30 kc, which will give approximately twice the number of channels. Again, all of the new channels have been assigned or reserved for radio services but some of these are not yet available. In the 450-460-mc band the channels have been divided in two—that is, from 100 kc to 50 kc—and the assignment of some of these additional channels is still to be settled.

How does this affect equipment?

These new channels with less *spectrum* space in which to operate a system required some changes in the technical performance of the transmitters. The changes in the rules also reflect these requirements.

In the 30-50-mc band, the frequency must be held within 0.002 percent of the assigned frequency and the deviation is limited to plus and minus 5 kc, except for low power equipments, which have more liberal stability limits.

In the 152-162-mc band, the frequency must be held within 0.0005 percent of that assigned and the deviation limited to plus and minus 5 kc.

In the 450-460-mc range, the frequency must be held within 0.0005 percent of that assigned and the deviation limited to plus and minus 15 kc.

In all bands the transmitter must have a filter in the circuit between the limiter and the modulator, which will attenuate the audio frequencies by 12 db per octave above 3000 cycles.

What about users with non-conforming equipment? Won't this obsolete their equipment?

As there is a large amount of equipment in operation that does not conform to these new technical requirements, the FCC set up a time schedule for compliance. The rules require that any new system authorized after August 1, 1958, conform and that all systems conform after October 31, 1963. The licensee of a system authorized before August 1, 1958, may continue to add units to that system under the old standards until October 31, 1963.

The new rules also require that all systems in the Industrial and Land Transportation Radio Services operating in the bands of 25-50 mc and 152-162 mc reduce their deviation to plus and minus 5 kc by February 1, 1959, and those in the Public Safety Radio Services do the same by August 1, 1960.

How would one go about complying with these new rules?

A user or prospective user should consider carefully what steps he should take to best comply with these new rules. For one putting in a new system the solution is simple—he should get equipment that complies with the new "split channel" rules.

For the user of an existing system, the solution is not so simple and several factors must be taken into account. With about five years that the existing equipment can be used, one should consider its useful life—is it more feasible to convert or to scrap the equipment at the end of five years

THE AUTHOR

In the early 30's George W. Pettengill engineered 60-mc radio for mooring of dirigibles and worked on equipment for forestry lookout towers. He produced models of 30-40-mc transmitters and receivers, and was probably the first to use squelch circuits for mobile communication. In 1938, he developed 375-mc radio relay equipment, quite an achievement those days.

Pettengill joined RCA in 1930, working on VHF radio and highpower amplifiers. In 1938 he transferred to the sales group and during World War II worked on military projects such as the proximity fuse. After the war, RCA Mobile Communications was reactiviated with George serving as technical adviser to both company and customer. When a product planning section was established he joined this activity and continues to serve in this function to date.

Born in Salisbury, Massachusetts, George Pettengill is a graduate electrical engineer of Wentworth Institute. Before joining RCA he worked for Westinghouse as student engineer, advancing to radio test foreman in 1921, and by 1928 to resident radio engineer.

and get all new? Any existing system without doubt will grow in size during this five year period and any added equipment should be such that it can be converted easily to the new "split channel" rules after the time limit of October 31, 1963.

You've mentioned transmitters — what about receivers?

These new rules concern themselves only with the technical operation of transmitters. To operate successfully on an adjacent channel basis will require that the receiver be made more selective to cut out the adjacent signals; however, there will be many systems that will not have any signals on adjacent channels that are strong enough to bother and there will be no need to modify receivers now.

What changes were made by FCC in classes of service?

In addition to the changes in the rules affecting the technical operation of the equipment, the FCC has modified some of the services and created several new ones.

The Local Government Radio Service now in the rules (effective June 30, 1958) will be available to cities and towns for their use in any official business such as police, fire, street, and water departments. This will fulfill a real need of smaller cities and towns where all of the mobile units for all different uses could be served by one base station. In the larger cities, channels will still be available so that the police or fire departments can set up their own system.

The Business Radio Service now available (August 1, 1958) includes any legitimate business and will accommodate most of those businesses that are now operating in the Class A portion of the Citizens Band.

The Manufacturers Radio Service now available (August 1, 1958) to manufacturers for material handling will accommodate those users now performing this service under Special Industrial Radio Service.

The Special Industrial Radio Service has been retained but in a modified form. The principal users left in this service are farms and ranches, contractors doing heavy construction, mining activities, fuel delivery services, and central mix concrete operators.

The Low Power Radio Service as such has been eliminated but a similar service with more channels and more liberal control requirements has been made part of the newly created Business Radio Service.

What are manufacturers planning that will help users?

The operators of land mobile radio systems are rightly concerned as to the steps they must take to conform to the new rules. For example, all RCA equipment supplied within the time period that would indicate the necessity of converting to the new rules after October 31, 1963, has been designed so that such a conversion is feasible and easy.

For these transmitters, crystals with improved stability are available; or in those cases where crystal ovens are required, simple kits are available for addition of this item.

Kits will be available to add the "splatter filter" to transmitters that do not already have it. All transmitters are already provided with controls that will permit the deviation to be adjusted to the specified value.

For receivers that need to be changed to better selectivity, intermediate frequency filters are available to match the service requirements. The interchange of these filters is a simple operation, which can be accomplished in any service shop.

Under the new rules some of present users will be required to change to a new frequency. RCA equipment includes all of the components necessary to tune it anywhere in the band for which it is designed; that is, 30-50 mc, 148-174 mc, etc., and a change to a new channel within that band would only require new crystals and retuning to the new frequency. ★ ★ ★

Shamrock Line Crosses Rugged Mountains

When the right-of-way crosses rugged mountains pipeline contractors need skill and know-how.

Groninger and King of Pampa, Texas, working on a new line recently met such a test southeast of Albuquerque, New Mexico. The steep rocky terrain of the Manzano Mountains in that area was the location of Indian pueblos during the time of Coronado's exploration in the Southwest.

The line is being constructed and will be operated by The Shamrock Oil and Gas Corporation for its affiliate, West Emerald Pipe Line Corporation. Shamrock's right-of-way for the new 6-in. products line from their Amarillo terminal to Albuquerque cuts through the barren heart of the Manzano Range.

Groninger and King are the contractors for the section from Palma, New Mexico, to Albuquerque. Eighty-seven miles of 6⅝-in. OD electricweld line pipe sold by Jones and Laughlin Supply Division, Tulsa, is being used in construction of this section of the new $4,000,000 line.

Shamrock Oil and Gas Corporation has marketing outlets in eight states. Principal office is at Amarillo with refineries and gasoline plants in the Texas Panhandle.

Pipelining in the clouds. Sideboom tractors ease a section of 6⅝-in. line pipe over the edge of one of the steeper slopes of the pipeline being constructed by The Shamrock Oil and Gas Corporation.

Formidable equipment such as that seen here was used by construction crews of R. H. Fulton Construction Company in laying a 118-mile section of 20-in. pipeline in West Texas.

EL PASO BUILDS TOWARD THE THREE BILLION MARK

A $138,400,000 expansion program nearing completion will give a capacity of 2,673,000,000 cu ft a day

Robert W. Adams
El Paso Natural Gas Company

CONSTRUCTION CREWS are nearing completion on a $138.4 million expansion program on El Paso Natural Gas Company's system in Texas, New Mexico, and Arizona.

Work started on the program early in April following approval of the company's application on March 26 by the Federal Power Commission.

Acting on two separate applications filed by the company, the FPC approved one in its entirety but in the other approved only facilities necessary to enable the company to connect new sources of gas supply.

Given complete approval was El Paso Natural's application to expand its pipeline capacity by 185,000,000 cu ft per day to supply additional gas to existing customers in Arizona and California.

In the second application, field facilities intended to increase the company's daily deliveries by 100,000,000 cu ft per day were approved but that portion of the application proposing additional main line facilities was returned to an FPC examiner for further study.

The new facilities will enable the company to supply additional gas to its customers in this ratio: 50,000,000 cu ft per day will go to Southern California Gas Company and Southern Counties Gas Company at Ehrenberg, Arizona; 25,000,000 cu ft per day will be turned over to these same customers at Topock, Arizona, while 75,000,000 cu ft per day will be delivered to Pacific Gas and Electric Company at Topock. The remaining 35,000,000 cu ft per day will be made available to existing customers in Arizona, principally in the Yuma area.

Major pipeline additions on the expansion program include 81 miles of 30-in. line, 176.8 miles of 20-in. pipe, 70 miles of 10-in. and 14 miles of 26-in. In addition, 57,200 compressor horsepower is being installed on the company's mainline system along with 39,920 compressor horsepower in the field.

Expansion Details

A quick rundown on the expansion is as follows:

1. A total of 67 miles of 30-in. pipeline is being installed as loop or parallel lines of varying lengths on the Permian-San Juan Crossover line between Plains in West Texas and Gallup, New Mexico.

Three sections of 30-in. are being laid. These include a stretch of 13.8 miles extending from the Roswell compressor station to the southeast; a 23.7 mile loop that is being added approximately mid-way between the Roswell and Lincoln compressor stations, and

Masses of pipe were stockpiled in a pipeyard near Sonora in West Texas during recent construction of 176-mile, 20-in. field feeder line.

a 29.7 mile stretch extending from a point 16.1 miles southeast of the Laguna compressor station to a point 13.6 miles northwest of the station. Contract was let to R. H. Fulton Construction Company of Lubbock.

2. A 176.8 mile, 20-in. line extending from a point near Sonora in West Texas to intersect with the company's existing 30-in. line about 20 miles southwest of its Plains compressor station. This addition is split into two major sections. These include a 118.8 mile stretch extending from a point near Sonora to the company's Sweetie Peck gasoline plant. R. H. Fulton was the contractor on this job. The other section is a 58 mile line extending from El Paso's Goldsmith plant to its Plains to Eunice 30-in. pipeline, tieing into the line about midway between Plains, Texas, and Eunice, New Mexico. Contractor was McVean and Barlow Construction Company of Odessa.

3. Seventy miles of 10-in., five miles of 12-in., and two miles of 16-in. paralleling an existing 5-in. line that ties into the company's 30-in. mainline on its Southern pipeline division at a point several miles north of Ehrenberg, Arizona, and extends in a southerly direction to Yuma, Arizona. Contract was let to Eastern Pipeline Contractors of Dallas.

4. Miscellaneous additions include 20 miles of 34-in. pipeline, looping the existing 34-in. San Juan Mainline near Topock, Arizona; some 14 miles of 30-in. pipeline looping the existing 30-in. line between the company's keystone main line compressor station and its Pecos River compressor station in West Texas; a total of 26 miles of 6-in. pipeline, connecting the two Arizona copper producing towns of San Manuel and Hayden, and 14 miles of 26-in. looping the existing 26-in. and 30-in. lines west of Gila, Arizona.

5. The addition of 57,200 compressor horsepower on the mainline system is broken down as follows:

(a) At the Plains station West Texas, 3500 hp is being added for a total station rating of 20,150. Bowden Construction Company of Odessa was awarded the contract.

(b) At Caprock turbine station in Lea County, New Mexico, a 5000 hp gas turbine is being added to the 5000 hp unit presently installed. Contract was let to O. L. Olsen Construction Company of Houston, Texas.

(c) At the Roswell station in Chaves County, New Mexico, 3400 hp will be added for a total station rating of 10,200. Contract was awarded to O. L. Olsen Construction Company.

(d) At the Belen turbine station, a 5000-hp gas turbine is being added to the 5000-hp gas turbine now operating. O. L. Olsen Construction Company is contractor.

(e) At the Laguna reciprocating station in Valencia County, New Mexico, O. L. Olsen, contractor, is adding 3400 hp to the 6800 hp now in operation.

(f) At the Bluewater compressor station in McKinley County, New Mexico, 2000 additional horsepower is being installed for a total station rating of 13,240. Contract was let to Delta Engineering Corporation of Houston, Texas.

(g) A completely new 17,500-hp station is being built on the San Juan main line near Window Rock, Arizona. Western Pipeline, Inc., of Austin, Texas, is contractor.

(h) At Leupp compressor station in Coconino County, Arizona, 5000 hp is being added to the 23,000 presently installed. This will be an electrically driven centrifugal compressor. Fluor Corporation of Los Angeles is the contractor.

(i) At the Williams compressor station, also in Coconino County, Arizona, 2400 additional horsepower is being installed for a total station rating of 25,400.

(j) A completely new 10,000-hp electrically driven centrifugal compressor station will be constructed on the San Juan main line near Seligman, Arizona. Fluor Corporation of Los Angeles is contractor.

Additional field compression is being installed at these plants: In New Mexico, 11,000 hp will be added at Jal No. 3; in West Texas, 800 hp will be installed at Vealmoor, 440 hp at Gulf-Waddell, and 2000 hp at Goldsmith; in the San Juan Basin, 10,600 hp will be added at Chaco, 1440 at Blanco, 660 hp at Ballard, 2000 hp at Largo, and 1000 hp at Lindrith; in the Texas Panhandle, 1980 hp will be installed at East Panoma and 6000 hp will be added at Panoma.

Absorption, Dehydration

In the way of other new field facilities, the company is building a 100,000,000 cu ft per day absorption unit at its Jal No. 3 treating and dehydration plant in Lea County, New Mexico, and is increasing the capacity of the absorption and dehydration units at its Chaco gasoline plant in the San Juan Basin by 100,000,000 cu ft per day. A new 40,000,000 cu ft per day compression and dehydration plant is being constructed near the town of Sonora in West Texas.

A new 65,000,000 cu ft per day dehydration unit will be added at the East Panoma plant in the Texas Panhandle, while additional dehydration will be

installed at these plants: Ballard, 15,000,000 cu ft daily and Largo, 32,000,000 cu ft daily, both in the San Juan Basin, and 19,000,000 cu ft daily at the Vealmoor plant in West Texas.

Capacity of the amine recovery unit at the Plains compressor station also will be increased by 215,000,000 cu ft.

Sources of Gas Supply

Various sources will supply gas for movement through the new installations. On the 185,000,000 case, up to 40,000,000 cu ft per day of dry gas will be taken from the Sonora field in Sutton County while 40,000,000 cu ft of residue gas daily will be drawn from various fields in Borden and Upton counties of West Texas. Another 5,000,000 cu ft of dry gas daily will be obtained from the East Panhandle field in the Texas Panhandle.

The remaining 100,000,000 cu ft will consist of dry gas, procured from various Pictured Cliff and Mesa Verde fields in San Juan and Rio Arriba counties in the San Juan Basin.

On the 100,000,000 application, for which new field facilities were approved, gas will be drawn from these sources: 8,000,000 cu ft daily of residue from the Gulf-Waddell plant in West Texas; 8,000,000 cu ft daily of residue from the Sun-Jameson plant in Coke County, West Texas; 30,000,000 dry gas daily from the East and West Panhandle fields; 25,000,000 dry gas from Beckham County in the Texas Panhandle; 2,000,000 dry gas daily from the Sonora field in West Texas, and 5,000,000 dry gas daily from fields in Lea County, New Mexico.

Cement foundations being poured for new field compression and dehydration facilities near Sonora in West Texas.

Compressors installed recently at new 2000-hp field compressor station near Sonora. Workers in foreground use shovel and airhammer in excavating for plant foundations.

Construction Methods

On the pipeline construction phase of the current expansion, conventional methods were used, generally, in laying practically all of the line.

In the ditching operations, construction crews of R. H. Fulton ran into a particularly rugged three-mile stretch near the company's Laguna compressor station on the San Juan-Permian Crossover Line.

In this section, the crews had to blast through layers of molten rock that were laid down centuries ago by an erupting volcano.

On the 176-mile, 20-in. Sonora feeder line, El Paso installed, for the first time on its system, spherical line separators to collect "drip" gasoline or liquids that condense out of the pipeline.

One of these separators was installed 20 miles downstream from the new Sonora compression and dehydration plant and the other was added 40 miles downstream from the plant.

El Paso is using these spherical separators instead of conventional facilities, because it is believed a better condensate recovery can be achieved and operating efficiency of the pipeline improved. A 220-bbl storage tank was erected adjacent to each separator.

In the construction of the 70.4-mile, 10-in. line to the Yuma, Arizona, area, the company is using white asbestos pipeline felt as a wrapping material to help reflect the intense heat from sunlight. Just recently, the temperature soared to 123 F in the Yuma area.

When El Paso completes its current expansion program, its authorized main line sales capacity will reach 2,673,000,000 cu ft per day. ★ ★ ★

How much do Products Mix in a Pipeline?

Here is how to calculate the extent of contamination when two different liquids are pumped in succession

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WHEN two miscible liquids are pumped in succession through a pipe, a mixing zone of gradually increasing length is formed at the place of the original boundary between the liquids. Although several factors may be responsible, the resulting effect has been quantitatively described by introducing a single coefficient of axial diffusion, K. A theoretical study on this subject was published by G. I. Taylor, which included results of his experimental work.[1,2]

In this article we wish to show that Taylor's theory cannot describe the whole range of available experiments, and a simple empirical equation is presented that correlates these data reasonably well.

Taylor* found that for straight tubes the dimensionless ratio $\frac{K}{aU}$ is determined solely by the Fanning friction factor γ‡ in the pipe:

$$\frac{K}{aU} = 10.1\sqrt{\tfrac{1}{2}\gamma} = 7.15\,\gamma^{1/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

It is known that γ depends on the Reynolds Number and the relative roughness in the pipe. In Tables 1-7 we have collected experimental data from the literature giving the relation between $\frac{K}{aU}$ and γ. Values of $\frac{K}{aU}$ in the table were calculated according to one of the following methods:

1. Use is made of the relation** between the length S of pipe containing contaminated liquid and effective diffusivity K:

$$S = 4\sqrt{tK}\,\text{erf}^{-1}\,(2y-1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

or:

$$\frac{K}{aU} = \frac{S^2}{16\,La\,[\text{erf}^{-1}\,(2y-1)]^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In these equations y is the fractional purity of the mixture at either end of the contaminated liquid. The inverse error function, $\text{erf}^{-1}\,(2y-1)$, may be calculated with tables in various handbooks, but for convenience the following table with some selected values is given:

Table of Selected Values.

y	$\text{erf}^{-1}\,(2y-1)$
0.50	0
0.80	0.594
0.90	0.901
0.95	1.165
0.97	1.328
0.99	1.640
1.00	—

2. The value of the effective diffusivity K is derived from an experimental curve showing the concentration history of the liquid at a given point of the pipe.

Values of the friction factor γ were calculated from the Reynolds Number and the relative roughness, by using Moody's charts.[3]

Fig. 1 shows that a number of experimental points do not fall on Taylor's line. It is suggested that Reynolds' analogy, on which Taylor's derivation is based, is not applicable in those cases.

A better correlation is possible by including the ratio of length L and radius *a* of the pipe in the equation. Hull and Kent from their experiments[7] found a dispersion proportional to $L^{0.56}$ instead of $L^{0.50}$, the expected factor, since they realized that the process was essentially similar to diffusion. Smith and Schulze[6] found dispersion proportional to $L^{0.62}$. We tried to correlate all available data by:

$$\frac{K}{aU} = C\gamma^n\left(\frac{L}{a}\right)^m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and we found $C = 2.4 \times 10^7$; $n = 3.6$; $m = 0.141$. Fig. 2 thus shows $\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$ as a function of the friction factor γ.

Combining Equations 2 and 4 gives a useful empirical expression for calculating the contaminated length, S, in pipes of all sizes, with any value of the relative roughness:

$$S = 1.96 \times 10^4\left(\frac{L}{a}\right)^{0.07}\sqrt{aL}\,\gamma^{1.8}\,\text{erf}^{-1}\,(2y-1)$$
$$. \quad (5)$$

*See page 453 of Reference 1.
**Reference 1, page 465.
‡In Europe a friction coefficient λ or ψ is commonly used, where : $\lambda = \psi = 4\gamma$.

For turbulent flow in smooth pipes we may use Blasius' relation:

$$\gamma = 0.0791\ Re^{-0.25} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

so that Equation 5 is then reduced to:

$$S = 146\ L^{0.57}\ \nu^{0.43}\ U^{-0.45}\ a^{-0.02}\ erf^{-1}\ (2y - 1) \quad . \quad . \quad (7)$$

It will be clear from the derivation that this formula is valid for any set of consistent units.

It is seen that S is proportional to $L^{0.57}$, in substantial agreement with Hull and Kent's data referred to above. Further it appears that the tube radius, *a*, scarcely influences the contaminated length S, as already found by Smith and Schulze.[6]

Procedure to Calculate the Length of Contaminated Liquid

To predict the length of contaminated liquid, the following steps should be taken:

1. Calculate the kinematic viscosity (ν) of a 50/50 (by volume) mixture of the two liquids.

2. Calculate the Reynolds Number from the inner diameter of the pipe (2 a), the mean linear velocity (U) and the kinematic viscosity computed in step 1, as

$$Re = (2a) \times (U)/(\nu).$$

3. Find the Fanning friction factor γ from the value of the Reynolds Number computed in step 2, taking into account the relative roughness of the pipe. Many charts have been published that give this information, e.g. Reference 3.

4. Calculate the ratio of length of pipe to inner radius, L/a.

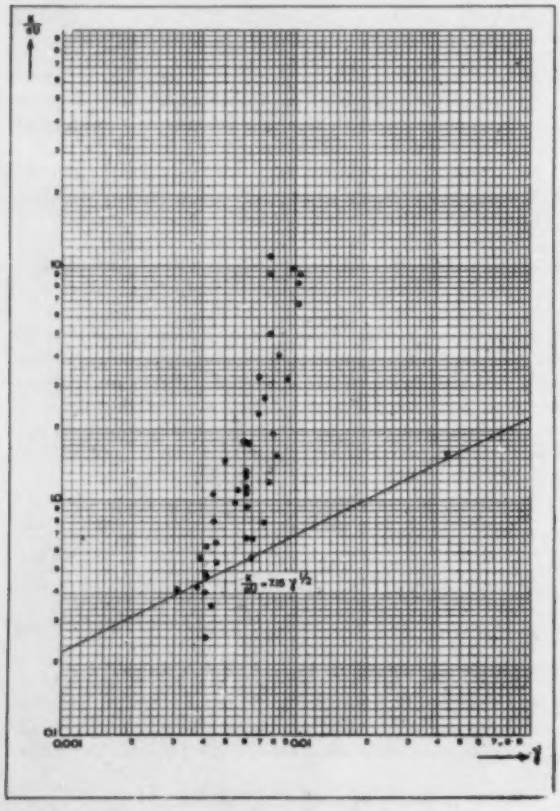

FIG. 1. Data plotted from Table I. Line: Equation 1, according to Taylor.

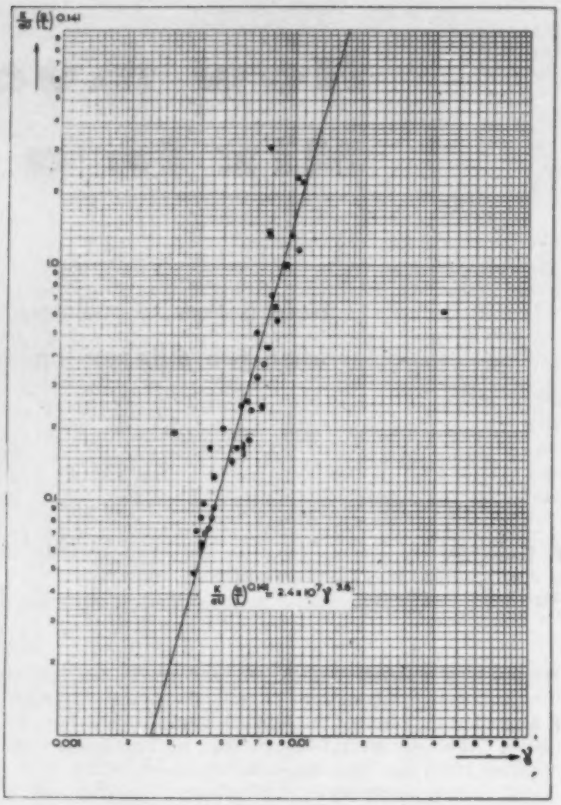

FIG. 2. New empirical correlation of data from Table I.

5. Select a value of the fractional purity y, allowable at either end of the volume of contaminated liquid. Find the value of $erf^{-1}\ (2y-1)$, either from a complete table in a mathematical handbook, or from the table of selected values given in this article.

6. Calculate the length of contaminated liquid S with Equation 5.

For turbulent flow in smooth pipes a simplified method may be applied, as follows:

1A. Ascertain length of pipe L, kinematic viscosity of 50/50 mixture (ν), mean linear velocity U, inner radius of the pipe *a*, allowable fractional purity y (see step 5, above).

2A. Calculate the length of contaminated liquid S with Equation 7.

Example:

Kerosine and gasoline are pumped successively through a 10-in. pipeline of 1000 km length. It is required to calculate the contaminated length at the exit of the pipe between the limits of 97/3 and 3/97, composition by volume. The following data are given: Kinematic viscosity of 50/50 mixture = 0.9 cS = 0.9×10^{-6} m²/sec. Mean velocity of flow: 1.1 m/sec.

It is assumed that the inner surface of the pipe is smooth.

Solution:

$$\text{Reynolds Number} = \frac{(2a)(U)}{(\nu)} = \frac{(0.254)(1.1)}{(0.9 \times 10^{-6})}$$

$$= 3.1 \times 10^5$$

By Moody's chart,[3] the Fanning friction factor is:

$$\gamma = \frac{0.0144}{4} = 0.0036$$

By Equation 5 the contaminated length is:

$$S = 1.96 \times 10^4 \left\{\frac{10^6}{0.127}\right\}^{0.07}$$
$$(0.127 \times 10^6)^{0.5} (0.0036)^{1.8} \text{erf}^{-1} (2 \times 0.97 - 1) =$$
$$(1.96 \times 10^4)(3.04)(0.356 \times 10^3)(3.97 \times 10^{-5})(1.328)$$
$$= 1100 \text{ m}$$

By Equation 7 the contaminated length is:

$$S = 146(10^6)^{0.57} \left\{\frac{0.9 \times 10^{-6}}{1.1}\right\}^{0.45}$$
$$(0.127)^{-0.02} \text{erf}^{-1} (2 \times 0.97 - 1) =$$
$$(146)(2.65 \times 10^5)(1.82 \times 10^{-3})(1.04)(1.328) = 975 \text{ m}$$

The last result, calculated according to Equation 7, is low because this equation was based on Blasius' relation Equation 6, which gives low values of the Fanning friction factor.

Recommended range for use of new equation:

As it is entirely empirical, the new correlation should not yet be used outside the range where it has been established. From the data presented in Table 1 it appears that this range is already rather wide. The following extreme values may be noted in this table:

Length of tube	:	$1.52 - 8.5 \times 10^5$ m
Diameter of tube	:	0.314 – 101.6 cm
Reynolds Number	:	3000 – 482,000
Fanning friction	:	0.0031 – 0.0104

As mentioned in the title, this article is concerned with mixing of liquids only; however, it is expected that the same correlation holds for gases, and the very few known data on mutual contamination of gases flowing in pipes seem to corroborate this view.

Symbols	Units*
a = inner radius of pipe	m
K = effective axial diffusivity	$m^2 sec^{-1}$
L = length of pipe	m
t = time of passage through pipe	sec
Re = Reynolds Number based on the viscosity of the 50/50 mixture	—
S = length of pipe containing contaminated liquid	m
$U = \frac{L}{t}$ = mean velocity in pipe	$m sec^{-1}$
y = fractional purity at either end of contaminated volume	—
ν = kinematic viscosity of 50/50 mixture	$m^2 sec^{-1}$
γ = Fanning friction factor	—

*Any other set of consistent units may be used in the formulae of this article.

APPENDIX

TABLE 1. From Reference 6. (Smith and Schulze.)

Fig. No. in Ref. 6	12	12	12	12	12	12	14	15	16	17
a = radius (m)	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254	0.0762	0.1016	0.1270	0.1524
L = length (m)	3.05×10^4	3.05×10^4	3.05×10^4	3.05×10^4	3.05×10^4	3.05×10^4	9.15×10^4	8.8×10^4	26.2×10^4	69.5×10^4
S = contam. length (m)	564	372	302	281	244	220	445	428	905	1420
y = fract. purity	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Re = Reynolds No.	5000	8000	15,000	20,000	50,000	500,000	143,000	218,000	482,000	450,000
γ = Fanning fr. factor	0.0098	0.0085	0.0074	0.0070	0.0060	0.0050	0.0046	0.0042	0.0039	0.0038
L/a	1.2×10^6	1.2×10^6	1.2×10^6	1.2×10^6	1.2×10^6	1.2×10^6	1.2×10^6	8.6×10^6	2.1×10^6	4.6×10^6
K/aU	9.54	4.14	2.72	2.36	1.78	1.44	0.66	0.47	0.57	0.426
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	1.32	0.575	0.377	0.328	0.247	0.200	0.0915	0.0708	0.0733	0.0489

TABLE 2. From Reference 4. (Fowler and Brown.)

Run No. in Ref. 4	133	98	119	108	173	209	196
a (m)	0.00397	0.00397	0.00397	0.00397	0.00157	0.00157	0.00157
L (m)	1.52	6.25	3.14	4.75	6.71	15.3	32.2
S (m)	0.35	0.47	0.56	0.54[5]	0.76	1.64	2.46
y	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Re	7530	19,800	8630	9380	5650	3670	3040
γ	0.0082[5]	0.0066	0.0080	0.0077	0.0092[5]	0.0102[5]	0.0104
L/a	383	1575	790	1198	4280	9740	20,500
K/aU	1.53	0.68	1.90	1.19	3.22	8.48	9.12
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	0.66	0.241	0.74	0.44	0.99	2.32	2.25

TABLE 4. From Reference 8. (Kohl and Newacheck.)

Fig. No. in Ref. 8	5	4	8
a (m)	0.0508	0.102	0.127
L (m)	3.0×10^4	6.0×10^3	1.0×10^5
width (at ½ value), (sec)	36.4	27	155
K (m2/sec)	0.104	0.033	0.085
Re	$3.9 \times 10^{5*}$	$2.1 \times 10^{5*}$	$1.9 \times 10^{5*}$
U (m/sec)	1.91	0.925	1.04
K/aU	1.07	0.35	0.64
L/a	5.9×10^5	5.9×10^4	7.9×10^5
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	0.165	0.0745	0.0952
γ	0.0044	0.0043	0.0042

*Estimated by present author.

TABLE 3. From Reference 7. (Hull and Kent.)

Table No. in Ref. 7	I	I and II	I and II	I and II	I and II	I and II	I and II	I and II	I and III	I and III	I and III
a (m)	0.254	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.1015	0.1015	0.1015
L (m)	8.0×10^3	3.0×10^3	2.2×10^4	6.9×10^4	$1.7^5 \times 10^5$	2.0×10^5	2.1×10^5	2.9×10^5	2.4×10^3	2.3×10^4	3.9×10^4
width (at ½ value), (sec)	—	67	211	402	669	746	770	895	24	102	120
K (m2/sec)	0.189	0.0718	0.0980	0.1140	0.1150	0.1350	0.1380	0.1330	0.029	0.054	0.0448
Re	103,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	3×10^5	3×10^5	3×10^5
U (m/sec)	1.38	0.82	0.82	0.82	0.82	0.82	0.82	0.82	1.10	1.10	1.10
K/aU	0.54	0.69	0.94	1.08	1.12	1.27	1.31	1.26	0.26	0.48	0.40
L/a	3.1×10^4	2.4×10^4	1.7×10^5	5.4×10^5	1.4×10^5	1.6×10^5	1.6×10^5	2.3×10^5	2.4×10^4	2.3×10^5	3.9×10^5
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	0.126	0.165	0.173	0.167	0.152	0.170	0.174	0.160	0.063	0.084	0.065
γ	0.0046	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062	0.0041	0.0041	0.0041

TABLE 5. From References 1, 5 and 9.

	Taylor, Reference 1			Shipley Reference 5	Allen & Taylor Reference 9
Fig. No. in Ref. 1	6	8	10	1	
a (m)	0.00476	0.00476	0.00455	0.095	0.508
L (m)	16.31	16.31	2.473	8.5×10^5	108
width (at ½ value), (sec)	0.316	0.61	0.305	1590	—
K (m2/sec)	0.0064	0.00513	0.0104	0.040	0.218
Re	1.93×10^4	1.18×10^4	1.2×10^4	1.1×10^5*	9.7×10^5
U (m/sec)	2.22	1.36	1.46	0.523	1.05
K/aU	0.572	0.80	1.56	0.81	0.41
L/a	3.4×10^3	3.4×10^3	5.4×10^3	9×10^5	222
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	0.18	0.25	0.64	0.083	0.19
γ	0.0065	0.0073	0.044	0.0045	0.0031

*Estimated by present author.

TABLE 6. From Reference 10. (Shell Oil Company.)

Fig. No. in Ref. 10	2	3	4
a (m)	0.127	0.127	0.127
L (m)	915	1609	3.94×10^4
width (at ½ value), (sec)	100	90	538
K (m2/sec)	1.66	0.77	0.98
Re	8000*	8000*	3000*
U (m/sec)	1.19	1.19	1.14
K/aU	11	5.1	6.8
L/a	7.2×10^3	1.27×10^4	3.1×10^5
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	3.14	1.35	1.14
γ	0.0078	0.0078	0.0104

*Estimated by present author.

TABLE 7. From Reference 11. (Shell Pipe Line Corporation.)

Fig. No. in Ref. 11	14	14	14	14	14
a (m)	0.1015	0.1015	0.1015	0.1015	0.1015
L (m)	7.5×10^4	7.5×10^4	7.5×10^4	7.5×10^4	7.4×10^4
S (m)	1400	854	610	488	458
y	0.97	0.97	0.97	0.97	0.97
Re	8×10^3	16×10^3	26×10^3	40×10^3	52×10^3
γ	0.0078	0.0070	0.0063	0.0057	0.0055
L/a	3.7×10^5	3.7×10^5	3.7×10^5	3.7×10^5	3.7×10^5
K/aU	9.12	3.38	1.72	1.10	0.96
$\frac{K}{aU}\left(\frac{a}{L}\right)^{0.141}$	1.39	0.51	0.26	0.167	0.146

Acknowledgment

The author wishes to thank Shell Oil Company, New York, and Shell Pipe Line Corporation, Houston, Texas, for permission to use some of their unpublished data.

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ONCE PROLIFIC GAS FIELDS BEING DEVELOPED FOR STORAGE

A new underground storage facility now being constructed in north-central Pennsylvania is expected to start supplying natural gas to East Coast consumers during the winter of 1959-60.

The Leidy and Tamarack gas fields in Clinton and Potter counties, once prolific producing pools, are being converted to one of the largest underground gas storage areas in the country.

Initial phases of the project now under way include construction of a compressor station — consisting of a compressor engine building, warehouse, auxiliary building, and office— reworking of all wells in preparation for storage, laying of storage lines to connect the wells to the station, and erection of 15 houses for key station personnel. Station and houses are going up at Tamarack in Leidy Township, Clinton County.

This first stage of compressor station construction includes the installation of three 2000-hp gas compressor engines and two 1000-hp engines. Ultimate horsepower when the facilities are eventually completed will total 27,000.

New York State Natural Gas Corporation, Pittsburgh, with a 50 percent interest in the project, is constructing the storage facilities and will act as operator. The other two participating companies are Transcontinental Gas Pipe Line Corporation, Houston, Texas, and Texas Eastern Transmission Corporation, Shreveport, Louisiana, each with a 25 percent share.

Only Transco will make use of the facilities now being constructed and will provide 30 billion cu ft of gas for the storage area during the summer months of 1959. Of this amount, 15 billion cu ft plus 5 billion cu ft already underground will be "cushion gas" to provide necessary reservoir pressure. The remaining 15 billion cu ft of "top gas" will be pumped to Transco's eastern markets during the 1959-1960 winter heating season.

Transco is currently laying a 192-mile pipeline from its main transmission facilities in New Jersey to the Leidy station. The line consists of 30-in. and 24-in. pipe.

About 15,000 acres in the pools proper are under lease for the new storage area in Clinton and Potter counties. Approximately 13,000 acres lie in what is known as the Leidy gas field and the remainder in the Tamarack field to the east and south of the Leidy field.

The area was once a rich gas producing region. Some of the largest wells ever drilled in the East were located here. The most productive of these was the Finnefrock well, which came roaring in with an open flow of more than 150,000,000 cu ft of gas per 24-hr period. The new Leidy station is being constructed on the farm where the Finnefrock well was drilled.

The Commonwealth of Pennsylvania and private land owners in the area are benefiting from the project. New York Natural has been paying rental on the land for some time. About half of the storage area is in state forest lands.

Ultimate capacity of the storage area will be about 105.6 billion cu ft of gas. Of this amount, about 45 billion cu ft will be "cushion gas." The 60 billion cu ft of "top gas" will be available for the three participating companies to serve their markets in Pennsylvania, New York, and New Jersey.

New York Natural and Texas Eastern are not developing their share of the facilities at this time. They will file requests with the Federal Power Commission when their market requirements dictate.

P 615.63

CAISSON FOR UNDERWATER REPAIR

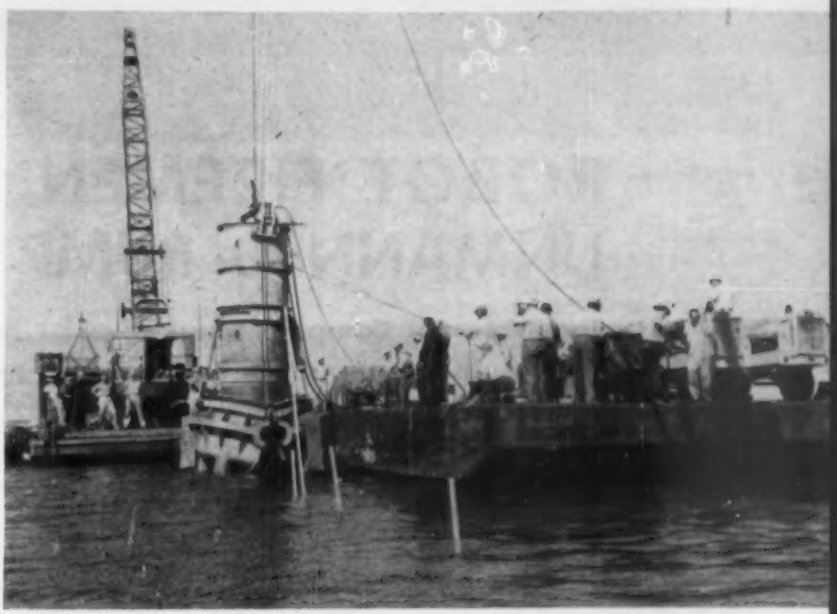
Successfully Field Tested

INTERSTATE OIL PIPE LINE COMPANY recently made a successful field test of an experimental caisson for underwater repair and connections to pipelines. The test was made on a 12-in. crude oil line in Barataria Bay, near Grand Isle, Louisiana.

Initial study and design of the caisson were made by William Law, Interstate's veteran mechanical consultant, who recommended its development. The development was undertaken by Interstate as a joint research project with Esso Research and Engineering Company, chief research affiliate of Standard Oil Company (New Jersey).

Law was the originator of several unique features such as the neoprene closure, internal hinges, and hydraulic operation. His design for the caisson was tried first in a working scale model one-eighth of normal size. Valuable suggestions by many persons both in and out of Interstate were incorporated into the full scale caisson.

The test was conducted under the supervision of O. B. Denny, district superintendent for Interstate at Raceland, Louisiana, and his staff. B. G. Walton of Interstate's engineering department served as project engineer for the test.



Underwater caisson is being lowered on the pipeline under the waters of Barataria Bay. Stakes in the foreground denote the location of the pipe. The caisson is aligned to be lowered over the pipe in approximately 7 ft of water. Note the heavy weights on extreme right and left of caisson and the hydraulic rams above each, which are used to open and close the caisson in clamping it around the pipe. Pipe at extreme top right is discharge line for pumping water out of the caisson after it is placed in position on the pipeline.

Heretofore, repairs and connections to underwater pipelines have been made either by raising the line above water or by using some makeshift type of caisson that was unwieldy and was not too satisfactory. Primary features of the new caisson are that it is economical, safe, portable, adaptable to different sizes of lines from 2 in. to 20 in., and adaptable to different depths of water. The initial tap and connection were made in one day with a minimum of auxiliary marine equipment as compared with several days and additional equipment that it took Interstate recently to repair a similar line by having to raise it above the surface of the water.

Constructed of ½-in. steel plate with stiffeners, the caisson is designed so that it can be used to make underwater repairs and connections in water up to 50 ft deep. The bottom of the caisson is bell-shaped and 7 ft in diameter with a vertical split and pipe sleeves midway up the side of the split. When clamped around the pipe for actual work, it has a deck on which workmen may stand to accomplish the job.

A top section, 5 ft in diameter and resembling a huge barrel, extends upward 6 ft. Additional barrel-like sections in 6 and 12-ft lengths of the same diameter can be joined to the top of the caisson, depending upon the depth of the water. Bottom and top parts of the basic caisson are connected by a continuous neoprene rubber sleeve that permits opening and closing of the clamps. Two hydraulic rams connect the bottom and top sections. These rams are connected by hose to a pump unit on the work barge. The hydraulic rams open and close the split section clamps around the pipe near the bottom of the caisson.

After preliminary preparations, such as staking the location and clearing away mud from around the line, the caisson is lifted by a crane from a barge and lowered over the line. Then the bottom section is clamped around the pipe by the hydraulic rams. Water in the caisson is then pumped out by a sump pump installed in the caisson, enabling the workmen to descend to the pipeline by a ladder constructed inside the caisson.

The caisson weighs approximately 16,000 lb. As many as 12 weights of 3900 lb each — rectangular iron blocks —can be hooked onto the bottom section to help overcome the bouyancy of the evacuated caisson. Depth of the water determines the number of weights to be used in any operation.

The test on the 12-in. line in Barataria Bay was made in about 7 ft of water, but the line was about 11 ft from the surface. Mud was jetted away from a section of the covered line for the test. Two weights were used, and two crane barges and a work barge were also employed in the operation.

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P 615.64

The Ohio Oil Company pumping station at Oregon Basin, Wyoming, which is protected by an automatic dry chemical piped system.

ROBOT FIREMEN PROTECT UNMANNED PUMP STATIONS

The Ohio Oil Company engineers its fire-fighting systems to fit individual locations. Here is how its dry chemical system works

K. Zimmerman
Supervisor of Safety
The Ohio Oil Company

FIRE PROTECTION for crude oil and products pipelines starts on the building engineer's drawing board.

Although today's new pumping stations are constructed of noncombustible material, there exists the ever-present danger of fire, due to the large quantities of flammable liquids being handled. Consequently, The Ohio Oil Company is making every effort to protect its physical properties with types of automatic fire extinguishing systems engineered for each particular location.

This article describes the automatic dry chemical piped systems installed in The Ohio Oil Company stations at Jamestown, Indiana; Jewett, Illinois; Oregon Basin, Byron, and Chatham, Wyoming. These systems are robot firemen, which keep a 24-hour vigil at the unmanned pump stations and will flood the area with dry chemical immediately on any rapid rise in temperature.

Installations are Flexible

Dry chemical piped installations are highly flexible. They may be adapted to nearly all flammable liquid and electrical hazards that should be protected against fire. In instances where water is objectionable, such as pumping stations where the pumps and motors are housed in the same area, the hazards are well adapted to protection by dry chemical piped systems.

Automatically operated systems are actuated by a rate-of-temperature-rise Heat Activated Device (HAD). Each system is equipped also with a manually operated control. These HAD's are extremely sensitive to any rapid increase in temperature such as would occur when a fire starts. This temperature increase causes an expansion of air within the bulb of the HAD. Expanding air exerts pressure, which is transmitted through a small copper tube to the nitrogen cylinder release located at the dry chemical unit.

The nitrogen cylinder release contains a diaphragm that is highly sensitive to changes in air pressure. When the pressure transmitted from the HAD reaches the diaphragm in the release, the slight movement in the diaphragm trips a lever on the mechanism, which releases nitrogen gas into the dry chemical tank, pressuring the extinguisher.

Rapid flow of nitrogen gas into the dry chemical tank fluidizes the dry chemical charge as pressure within the extinguisher increases. When pressure reaches 165 psi a bursting disk ruptures allowing dry chemical to enter the distribution piping. Taking less time than the few seconds you've needed to read about it, this pressure build-up and fluidization process assures proper dry chemical to gas ratios and an adequate rate of dry chemical flows through the piping. Strategically located distribution nozzles within the fire area control and discharge the dry chemical in the most effective stream patterns.

Dry chemical does not flow through a pipe like gas, nor does it flow like water. Design of the piping layout including pipe sizes is very important. Realizing this, The Ohio Oil Company utilizes the technical services of the manufacturer's Special Equipment Department. This service assures us that the engineering will comply with Underwriter's Laboratories and National Fire Protection Association standards and that the fire protection system will be approved by our insurance carrier for insurance rating purposes.

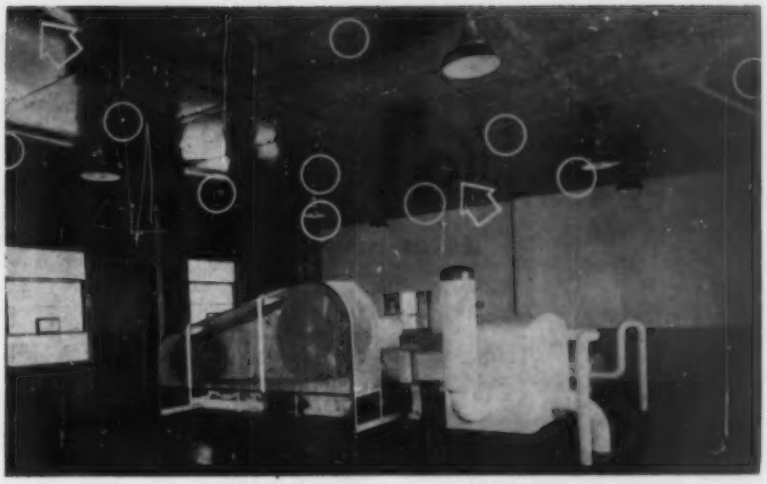
An electrical switch, mounted on the side of the nitrogen cylinder release, is energized by the release when a fire activates the system. Thus, through direct connection or relays from this electrical switch the pump motors, lights, and fans are turned off, eliminating possible sources of reignition.

In several of our stations where one dry chemical unit provides protection to two or more separate hazards, selector valves are used. The selector valve automatically opens the proper valve to the dry chemical piping leading to the hazard involved in the fire.

Piping Layout Important

The Ohio Oil Company systems are installed using standard weight galvanized pipe and fittings. As this pipe is readily available, installation would

appear to be quite simple; however, neither hydraulic principles nor gas laws can be applied to dry chemical fire protection systems. Piping for these systems carries billions of minutely sized particles suspended in a gas stream moving at high velocity. Because there is a tendency for dry chemical to be thrown to the outside when passing through an elbow, the piping layout is particularly important. We follow the piping layout prepared by the manufacturer's design technicians. Deviation from the engineered design could result in unbalance of the distribution system with some nozzles getting an overabundance of dry chemical and other nozzles getting an insufficient quantity to perform properly.



A portion of the Oregon Basin station pump room. HAD's (heat activated devices) are indicated by arrows and dry chemical nozzles visible in the illustrations are circled. All piping is concealed above the ceiling.

Chemical Flow Rates

Much has been learned about flow rates and pressure drops. A certain minimum flow rate of dry chemical is required for proper functioning of each system. Below the minimum, the solid particles will separate from the gas and surging will result.

The manufacturer's research and development testing proved that pressure drop through an elbow is approximately the same as the drop through 20 ft of straight pipe, whereas a pressure drop through a tee is equivalent to that of 45 ft of straight pipe. Design rate of flow for each Ansul piped system is calculated by figuring pressure drops for pipe and fittings of each size. Before each system is installed we can be assured the rate of flow will be adequate to prevent surging of the dry chemical. These data are applicable only to Ansul dry chemical systems because it is determined by a specified ratio of Ansul dry chemical to gas. Should this ratio change the data would change accordingly.

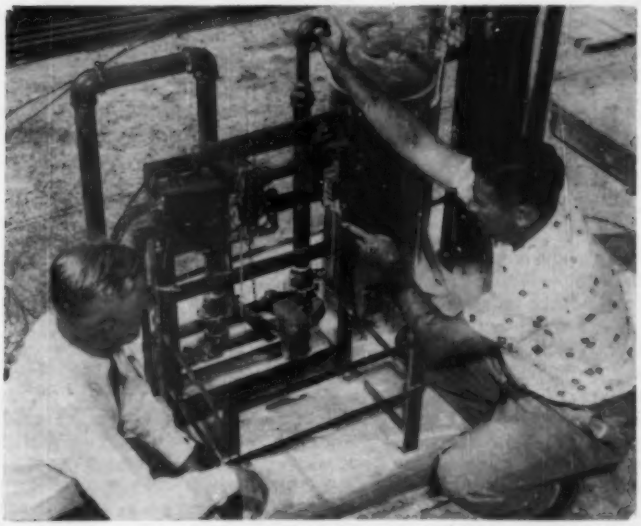
At all installations a safety factor of 100 percent is used with regard to the quantity of dry chemical. In other words, one half the dry chemical provided should extinguish any flammable liquid fire occurring in the pump station.

Maintenance Program

The maintenance program on our systems is comparatively simple. The HAD and automatic release systems and power shut off relays are tested quarterly. At the same time the fill cap is removed from the chemical tank and the quantity and quality of the chemical is checked. Semi-annually, in a special inspection technique developed by our company, the dry chemical tank is bypassed and the nitrogen cylinder is discharged through the piping and nozzles. This assures us that the lines and ports on the nozzles are clear of obstructions or foreign material.

The automatic piped systems we have installed do not protect what could be considered large pumping stations. Our greatest hazard is protected with a 500-lb capacity dry chemical unit. At these particular locations, however, installation of equipment for any other extinguishing agent, particularly water, would be either impossible or economically unsound.

We are satisfied that our dry chemical fire protection systems can be depended upon to operate automatically and extinguish any possible fire occurring at the unattended pump stations where they are installed. ★ ★ ★



J. R. West, manager, Sales Development Department, Ansul Chemical Company (right) and the author examine the automatic release mechanism on a dry chemical piped system.

The PS-500 piped system extinguisher at Byron, Wyoming, discharges dry chemical through the selector valve manifold to the left of the extinguisher. Here dry chemical is directed through the particular piping leading to the area involved in the fire. To the right of the dry chemical tank is the nitrogen cylinder and release mechanism used to actuate the piped system.

Pipeline Projects

Transco Plans Third Parallel Line

Transcontinental Gas Pipe Line Corporation has filed an application with the Federal Power Commission for a certificate to authorize $51,000,000 of additional construction to be completed by November 1959.

E. Clyde McGraw, Transco president, said this proposed construction would be the first step in a long-range program to build a third line parallel to the other two in the company's system from the natural gas fields of the Gulf Coast to the New York City-New Jersey-Philadelphia metropolitan area.

McGraw said that this 1959 proposed construction would be in addition to the current major program now underway. More than one-half of the estimated $16.,000,000 of construction now in progress will be completed by the end of 1958, enabling Transco to meet present commitments this winter for increased deliveries of natural gas, he said.

The now proposed additional construction will enable an increase of 82,000,000 cu ft of natural gas in daily allocations to 43 customers plus an increase of 8,000,000 cu ft daily transported for Sun Oil Company. Transco currently transports 20,000,000 cu ft of firm gas per day for Sun to the latter's refinery at Marcus Hook, Pennsylvania.

In the new application Transco proposes to build 149 miles of additional 36-in. diam main line loops and 34 miles of 20-in. and 24-in. additional gathering laterals. Two new compressor stations, one in Nueces County, Texas, and one in St. Helena Parish, Louisiana, are proposed. Also, additional compressors would be installed at eight of the 25 existing Transco main line compressor stations between Texas and New York City.

The 1959 construction applied for will increase total proposed daily allocations to 1,281,000,000 cu ft, exclusive of storage, and to 1,621,000,000 cu ft per day including natural gas from storage properties.

Companies Plan Joint Line to Export Canadian Gas

Westcoast Transmission Company and Alberta and Southern Gas Company now plan jointly to construct a pipeline for export of Canadian gas rather than build separate lines as previously proposed.

Proposed is a 36-in. line costing about $40,000,000, laid from the Alberta border, through Crowsnest Pass, to Kingsgate, British Columbia, at the British Columbia-Idaho border.

J. K. Horton, president of Alberta and Southern, and Frank M. McMahon, president of Westcoast, in making the announcement, said studies indicated there would be a considerable saving in transportation costs.

Alberta and Southern Gas Company was organized by Pacific Gas and Electric Company to construct a line from Alberta to San Francisco. Westcoast would sell to Pacific Northwest Pipeline Corporation, subsidiary of El Paso Natural Gas Company.

Officials said a similar joint agreement might be worked out for building the United States segments of the pipeline.

An application for the Canadian part of the project will be filed with the Alberta Oil and Gas Conservation Board.

Midwestern-Tennessee Gas File New Applications

New companion applications to provide the Chicago-Gary area with major new natural gas supplies from the prolific Texas-Louisiana Gulf Coast have been filed with the Federal Power Commission by Midwestern Gas Transmission Company.

Midwestern applied to construct a 350-mile, 30-in. pipeline costing $50,815,000 to deliver 360,000,000 cu ft of gas per day to three big Chicago area utilities, Peoples Gas Light and Coke Company, Northern Indiana Public Service Company, and Northern Illinois Gas Company.

Tennessee Gas filed a supporting application to build $61,548,000 in facilities including 158 miles of 36-in. pipeline parallel to its existing system in Louisiana and Mississippi to furnish Midwestern its gas supply at a connection at Portland, Tennessee.

Midwestern's pipeline would run north through Tennessee, Kentucky, Indiana, and Illinois and end at a connection near Joliet, Illinois, with the facilities of Chicago District Pipe Line Company, a Peoples Gas subsidiary, which will connect with the systems of Peoples and the other two utilities.

The Midwestern and Tennessee Gas applications were filed on the second business day after the FPC issued an order that denied long-pending applications of Midwestern and competing pipelines, but which suggested the filing of new applications to cure shortcomings the FPC said existed in all the denied proposals.

The FPC set forth specific suggestions for new projects, pointing out that "particularly desirable is a well-founded project to serve the seemingly endless requirements of the Chicago market for both industrial and space-heating gas."

On the day after the FPC order was issued, Midwestern and Tennessee Gas sent the FPC a letter outlining their plans to divide their former project into two parts and to file separate applications covering each. The above filing was the first of the two. The second will be filed about January 1. Based on a Canadian gas supply, it will propose a new pipeline to serve communities principally in Minnesota and Wisconsin, and in the Upper Peninsula of Michigan.

Colorado Interstate Files For Gas Pipeline to Utah

Colorado Interstate Gas Company has filed an application with the Federal Power Commission for its $91,000,000 Utah project. Plans were announced in August for this expansion program, which is in conjunction with those of El Paso Natural Gas Company and Pacific Northwest Pipeline Corporation.

Under the plan, Colorado Interstate will sell 200,000,000 cu ft of gas daily to El Paso Natural near Green River, Wyoming. Initially, Colorado Interstate will transport this gas and an equal volume from Pacific Northwest through a new pipeline to be built to Provo, Utah. From that point El Paso will take the gas to the Arizona-California border for ultimate consumption in California.

Iran to Mediterranean Pipeline Pact Signed

Legal basis for construction of a pipeline from Iran to the Mediterranean Sea has been provided in an agreement signed by National Iranian Oil Company and the Turkish foreign minister, according to the U. S. Embassy at Tehran.

The pipeline, approximately 935 miles long, will cost about $500,000,000, a company official stated, and the agreement is said to be for 80 years.

December 15 Date Set for Transwestern Hearing

The Federal Power Commission has set December 15, 1958 as the date for hearings to begin on long-discussed plans to establish a second out-of-state supplier of natural gas for the ever increasing natural gas requirements for California.

The commission will consider the application of Transwestern Pipeline Company, Houston, Texas, for authority to construct and operate a 1265-mile gas transmission system from the Panhandle and West Texas areas of Texas for delivery of natural gas to Pacific Lighting Gas Supply Company at Topock on the Arizona-California border.

Transwestern Pipeline system will have an initial capacity to deliver to Pacific Lighting 300,000,000 cu ft of gas daily with facilities available to deliver 345,000,000 cu ft to meet peak day requirements.

Transwestern's main line will consist of 670 miles of 30 in. diam line from Roswell, New Mexico, to Topock, Arizona, on the California border. In addition there will be two main line laterals of up to 24 in. diam delivering gas to the Roswell junction, one from the Permian Basin area in West Texas and the other from the Texas Panhandle area. The proposed pipeline system can be expanded to a maximum of 640,000,000 cu ft of gas daily with installation of additional compressor facilities.

While not in the company's initial construction plans, a third major lateral from the Four Corners area to the main line at Gallup is under consideration by Transwestern officials. The company has acquired gas reserves in the San Juan Basin of northwest New Mexico.

Transwestern plans call for initial installation of 40,960 total hp at five compressor stations to be located at Roswell, Scholle, and Gallup, New Mexico; Winslow and Seligman, Arizona, and three field booster stations. Additional compressor stations will be added as the volume of deliveries increases.

Modern compressor station design will enable fully automatic operation of the pipeline by remote control. Officials of the pipeline have disclosed that the proposed facilities have been designed to include stronger yield pipe than heretofore used by any other gas transmission system.

Organizers of the Transwestern line were Monterey Oil Company of Los Angeles, W. K. Warren, Tulsa, and J. R. Butler & Associates of Houston. Mills Cox, a veteran of 35 years in the gas and oil business, is president of the company. Prior to joining Transwestern, Cox was a vice president of Texas Eastern Transmission Corporation.

Gulf Interstate Company of Houston has designed the proposed pipeline facilities for Transwestern.

Two Short Projects, Atlantic Seaboard Get FPC Approval

The Federal Power Commission has authorized Atlantic Seaboard Corporation to construct gas pipeline facilities consisting of approximately 12 miles of 26-in. loop line in West Virginia between its Seneca and Lost River compressor stations, and about 11.7 miles of 26-in. loop line in Shenandoah County, Virginia, east of the Lost River station, both on its Cobb-Rockville line.

FPC Accepts Transco's Offshore Application

An application by Transcontinental Gas Pipe Line Corporation to construct and operate three purchase laterals and meter stations to take natural gas from offshore Louisiana, has been accepted for filing, the Federal Power Commission announces.

Transco proposes to construct two 16-in. laterals, one 13 miles long and the other about 1.83 miles in length. The third lateral would be approximately 0.71 miles of 12-in. line. The estimated cost of the proposed facilities is $2,200,000. The FPC, on October 22, granted Transco temporary authority to construct and operate the two shorter laterals and their appurtenant meter stations.

The facilities will be used to receive natural gas purchased from the Superior Oil Company from the Block 71 and Block 76 fields, offshore Vermilion Parish, Louisiana. Transco estimated the additional gas reserves that would be available at approximately 275,000,000,000 cu ft.

FPC Clears Way For Permian's Emperor Project

The Federal Power Commission has authorized Permian Basin Pipeline Company to construct and operate facilities to take natural gas from the Emperor field, Winkler County, Texas.

Permian will construct about 60.9 miles of 16-in. lateral supply line, approximately 11.3 miles of various diameter field lines, and nine meter stations, to purchase, receive, dehydrate, and transport natural gas produced in the Emperor field by Sun Oil Company, Phillips Petroleum Company, and Tidewater Oil Company.

Mississippi River Fuel Will Take Gas From ALG

The Federal Power Commission has authorized Mississippi River Fuel Corporation to construct and operate pipeline facilities, at an estimated cost of $3,655,400, to enable it to purchase and transport natural gas from Arkansas Louisiana Gas Company.

Mississippi River Fuel will construct approximately 36.8 miles of 26-in. transmission line loops; about 3.8 miles of 10-in. lateral supply line, and a 1320-hp compressor station at Minden, Webster Parish, Louisiana. The natural gas will be purchased at Arkansas Louisiana's Ruston gasoline plant in Lincoln Parish.

The FPC also authorized Arkansas Louisiana to construct a 1320-hp compressor and meter station, at a cost of about $331,800, and to sell up to 35,700,000 cu ft of natural gas daily to Mississippi River Fuel. Arkansas Louisiana will sell the gas from October 15 of each year through April 16 of the succeeding year for a five-year period ending April 16, 1963, and smaller volumes until May 1, 1963.

Texas Gas Gets Authority For $20,000,000 Program

Texas Gas Transmission Corporation has been authorized by the Federal Power Commission to carry out an expansion program costing $20,169,638. Included are 126 miles of various pipeline loops, installation of 9040 hp in existing compressor stations, construction of a new 1800-hp station, and addition of miscellaneous equipment to existing stations. The new facilities will be in Louisiana, Arkansas, Mississippi, Kentucky, Indiana, Illinois, and Tennessee.

Texas Gas also will expand its existing storage facilities at Oaktown and Alford fields in Indiana, and the Dixie and Hickory School fields in Kentucky, principally by reconditioning existing storage wells and enlarging the gathering system. The company will begin operation of its Wilfred storage field, Sullivan County, Indiana.

The new facilities will increase capacity of the Texas Gas system by 133,700,000 cu ft a day.

Pipeline Being Laid In Southern Wyoming

Teton Pipeline Corporation, subsidiary of Western Crude Marketers, Inc., Denver, Colorado, is constructing a 6-in., 25-mile line from the Sheldon Dome, Northwest Sheldon Dome, and Rolff Lake fields of Fremont County, southern Wyoming, to the Pilot Butte area. At Pilot Butte connections will be made with Service Pipe Line Company and Platte Pipe Line Company.

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Projects

New Arkansas Gas Pipeline Will Extend Across State

A $15,000,000 industrial gas pipeline development for Arkansas, which will extend from Aetna field, near Clarksville, across the state to Helena on the Mississippi River, has been given formal approval by the Arkansas Louisiana Gas Company board of directors.

The announcement was made by W. R. Stephens, board chairman and president, who also disclosed the formation of another wholly-owned subsidiary of ALG, Arkansas Industrial Pipeline Corporation.

The construction program involves two major segments. First segment will extend from Perla, Hot Springs County, eastward approximately 130 miles to Helena. This line, estimated to cost $9,000,000, will enable ALG to serve the new generating plant of Arkansas Power and Light Company, scheduled for completion early in 1961. It is designed as an 18-in. line, and will be constructed by the new subsidiary, Arkansas Industrial Pipeline Corporation.

The second segment, from the Aetna field, just west of Clarksville, to Perla, a distance of approximately 105 miles, will be constructed by Arkansas Louisiana Gas Company.

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PIPELINE PERSONALS

Dwight B. Sprow, recently appointed executive vice president of Houston Texas Gas and Oil Corporation and Coastal Transmission Corporation, has been elected to the board of directors of both corporations. **G. B. Bennett,** recently appointed vice president of sales and operations for Houston Texas Gas and Oil Corporation, also has been elected to the board of directors of that corporation. **E. P. Shanahan** has been named vice president and comptroller of The Houston Corporation, Houston Texas Gas and Oil Corporation, and Coastal Transmission Corporation.

D. B. Sprow

E. P. Shanahan

G. B. Bennett

Henry P. Hellinghausen, manager of the material-traffic department of Interstate Oil Pipe Line Company, Shreveport, Louisiana, has retired. Hellinghausen joined Oklahoma Pipe Line Company, an Interstate predecessor, in 1917 as a clerk and was purchasing agent from 1923 to 1938 when he was named assistant secretary of that company. A year later he became secretary; and during the next five years his responsibilities included the positions of treasurer and chief accountant. From 1930 to 1944, Hellinghausen was a director of Oklahoma Pipe Line Company. With the merger of Oklahoma Pipe Line Company and the pipeline department of Standard Oil Company of Louisiana into Interstate in 1945, Hellinghausen was named treasurer. He has resided in Shreveport since 1950 and, with the transfer of Interstate's general offices from Tulsa to Shreveport in 1951, became material-traffic manager.

F. Roy Ball succeeds Hellinghausen as manager of the material-traffic department. **Robert B. Giezentanner** has been named assistant manager of the material-traffic department to succeed Ball in his former position.

Otis G. Bryant has been promoted to the position of chief engineer for Houston Pipe Line Company. As head of the engineering department, Bryant will be responsible for the planning, design, and construction of all new pipelines and related facilities, and for furnishing general engineering and technical services to management and other departments of the company.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

WITH THE PIPELINE CONTRACTORS

● **R. H. Fulton & Company, Box 1526, Lubbock, Texas.** Has 21 miles of 26-in. from Fritch, Texas, northward, and 205 miles of 36-in. to a point near Meade, Kansas, for *Natural Gas Pipeline Company of America*, and will also build segments of the line from Offerle to Lincoln, Kansas. Also has contract for 92 miles of 6-in. crude line for *Jayhawk Pipe Line Company* extending from Meade to Elkhart, Kansas. The system includes 83 miles of main line and a 9-mile lateral.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has 62 miles of 20-in. crude line for *Shell Pipe Line Corporation* from the vicinity of Nairn, Louisiana, north to Norco refinery above New Orleans. Also approximately 22 miles of 14-in. natural gas pipeline for *Texas Eastern Transmission Corporation* from Opelousas station south to Rayne field, Louisiana.

● **Midwestern-Walco Contractors, P.O. Box 11507, 1431 4th Street South, St. Petersburg 33, Florida.** Awarded contract by *Houston Texas Gas and Oil Corporation* to lay 702 miles of 24-in. main line between Zachary, Louisiana, and Kissimmee, Florida.

● **Mid-States Construction Company, P.O. Box 417, Mt. Vernon, Illinois.** Has been awarded approximately 150 miles of 3½-in. to 16-in. pipeline by Harbert Construction Corporation, prime contractor for *Houston Texas Gas and Oil Corporation in Florida*.

● **Harbert Construction Corporation, P.O. Box 1369, Birmingham, Alabama.** Has nearly 500 miles of 18-in. and 20-in main gas lines and more than 600 miles of 4-in. through 16-in. lateral lines under contract with *Houston Texas Gas and Oil Corporation* from Bradenton, Florida, to Miami, Florida.

● **Hunsaker Trucking Contractor, Inc., P.O. Box 97, Carrollton, Texas.** Stringing 95 miles of 12-in. from Cayuga to Riesel, Texas, for *Bi-Stone Fuel Company*. Also 104 miles of 24-in. for *Coastal Pipe Line Corporation* from Smith Point, Texas, to the west bank of the west fork of the Calcasieu River, north of Sulphur, Louisiana.

● **Midwestern Contractors, Inc., 130 West Liberty Drive, Wheaton, Illinois.** Has been awarded a contract by *Standard Oil Company of New Jersey* to install approximately 24 miles of 8-in. pipeline from the Chicago Sanitary Canal to O'Hare Air Field along State Route 83.

● **Western Pipe Line, Inc., P. O. Box 1076, Austin, Texas.** Laying 112 miles of 24-in. and various size pipe in southern Louisiana for *Southern Natural Gas Company*.

● **Contracting & Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Laying 137 miles of 12-in. from Wood River to Champaign, Illinois, and 112 miles of 12-in. from Champaign to Griffith, Indiana, for *Wabash Pipe Line Company*.

● **Majestic Contractors Ltd., 408 Royal Trust Building, Edmonton, Alberta, Canada.** Has undetermined amount of distribution system in the Toronto, Ontario, area for *Consumer Gas Company of Toronto*. Also an undetermined amount of gas gathering system for *Producers Pipeline Company* in the Estevan, Saskatchewan, area.

● **H. C. Price Co., Price Tower, Bartlesville, Oklahoma.** Has 121.6 miles of 20 and 24-in. for *Southern Natural Gas Company* in Alabama, Mississippi, and Georgia. Approximately 65 miles of 24-in. in Louisiana for *Transcontinental Gas Pipe Line Corporation*.

● **APV Company, Inc., Continental National Bank Building, Fort Worth, Texas.** Has contract to install a triple pipeline crossing under the San Juan River, including two 34-in. lines and one 6-in. line located on the Navajo Indian Reservation in the Four Corners area of New Mexico, for *El Paso Natural Gas Company*.

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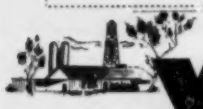

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● **B. C. Hall Constructors, Inc., P.O. Box 644, Aztec, New Mexico.** Has contract to build an undetermined amount of various sizes of pipelines ranging from 4-in. through 20-in. for *El Paso Natural Gas Company* in the Four Corners area of New Mexico.

● **Glaser Construction Company, Inc., P.O. Drawer 1387, Oil Center Station, Lafayette, Louisiana.** Has contract to lay about 50 miles of 8, 12, and 16-in. pipe for *Shell Pipe Line Corporation's* Delta crude oil pipeline in southern Louisiana.

● **Engineers Limited Pipeline Company, 225 Bush Street, San Francisco 4, California.** Has 102 miles of gathering lines in Aneth field, Utah, for *El Paso Natural Gas Company*.

● **Trojan Construction Company, Inc., 1416 N. Robinson, Oklahoma City 3, Oklahoma.** Has contract for take-up and reconditioning of 140 miles of 12-in. and 140 miles of 8-in. pipe from Teague to Huffman, Texas, for *Sinclair Pipe Line Company*.

● **Oklahoma Contracting Company, P.O. Box 13227, Dallas 20, Texas.** Has contract for 130 miles of 24-in. between Lake Charles, Louisiana, and Baton Rouge, and 150 miles of 20-in. from Robstown to Bay City, Texas, for *Coastal Transmission Corporation*. Laying 100 miles of 30-in. for *Creole Petroleum Corporation* between Temblador and Caripito, Venezuela. Has 96 miles of 30-in. from Columbus, Mississippi, to the Tennessee River for *Tennessee Gas Transmission Company*.

● **Delta Engineering Corporation, P.O. Box 13256, Houston 19, Texas.** To build pump stations at Main Pass, Southwest Pass, Ostrica and Pilottown in southern Louisiana for *Shell Pipe Line Corporation's* Delta crude oil pipeline.

● **Engineering-Construction Company, First National Bank Building, Tulsa, Oklahoma.** Has 44 miles of 6-in. crude line for *Jayhawk Pipe Line Company*. The lateral connects the Pleasant Prairie pool, near Lakin, to Jayhawk's main system, south of Plains, Kansas.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston 2, Texas.** Has 30 miles of 30-in. for *Transcontinental Gas Pipe Line Corporation* between the Delaware River and Princeton, New Jersey.

● **Station Construction Company, 2807 Buffalo Speedway, Houston 19, Texas.** Has contract to build Norco terminal and Loutre Junction facilities in southern Louisiana for *Shell Pipe Line Corporation's* Delta crude oil pipeline.

● **Grayco Constructors, Inc., P.O. Box 4147, Austin, Texas.** Constructing 119 miles of 30-in. for *Tennessee Gas Transmission Company*, from Columbus to Heidelberg, Mississippi.

● **Eastern Pipe Line Contractors, 820 Mercantile Building, Dallas, Texas.** Has 79 miles of 10-in. between Quartzsite and Yuma, Arizona, for *El Paso Natural Gas Company*.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **O. R. Burden Construction Corporation, P.O. Box 5216, Tulsa, Oklahoma.** Constructing gathering system in Jack and Wise counties, Texas, for *Natural Gas Pipeline Company of America* to connect 84 new wells. Has construction of approximately 90 miles of 12-in. natural gas line for *Coastal Transmission Company* starting near Faysville, Texas, and running northeastward and ending near Robstown, Texas.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has undetermined amount of gathering system line for *El Paso Natural Gas Company* in the Four Corners area of New Mexico and Colorado. Also, an undetermined amount of various diameter lines in the Big Piney field near Kemmerer, Wyoming, for *Pacific Northwest Pipeline Corporation*.

● **J. Ray McDermott, Inc., P.O. Box 38, Harvey, Louisiana.** To install major crossings of the Mississippi at Nairn and Destrehan, Louisiana, as well as three other water crossings, for *Shell Pipe Line Corporation's* Delta crude oil pipeline in southern Louisiana, which will move crude to Shell Oil Company's Norco, Louisiana, refinery 18 miles west of New Orleans from terminals on the southwest and southeast tips of the Mississippi River delta.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has contract to build segments of a *Natural Gas Pipeline Company of America* line, consisting of 185 miles of 36-in. in Nebraska and Kansas, and 98 miles of 34-in. in Iowa. Also has been awarded a contract by *United Gas Pipe Line Company* to lay 37.28 miles of 30-in. pipeline from Lyman to Helena, Mississippi.

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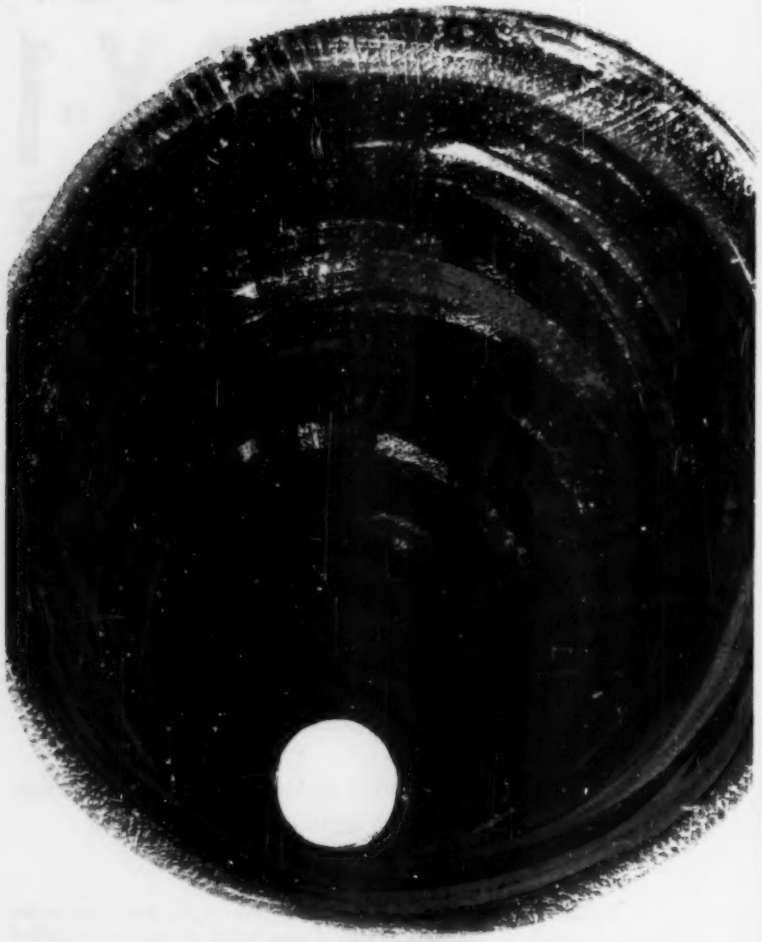

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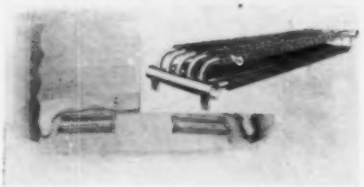


Incorporating a new horizontal or platform design for installation in floating roof tanks, Model FR-11 Thermo-Flo tank heaters can be installed through a 20-in. diameter manway. Maximum height installed is 15 in. from the tank bottom. The heaters are mounted on short, rigid legs, to allow a minimum clearance of the tank bottom of 2 in. This clearance, plus convection effects, keeps the heater from becoming buried in sediment on the tank bottom and facilitates tank cleaning. *Brown Fintube Company.*

Circle number (81) on reply card.

New Use for Viton

Viton, the versatile new broad temperature range polymer developed by DuPont, is now being used to manufacture vital packings, seals, and gaskets by The Garlock Packing Company. This manufacturer has developed basic formulations of Viton with durometer hardness ranging from 60 to 90 and will use these formulations in manufacturing items for application in which maximum resistance to deterioration by heat, oils, solvents, and many corrosive liquids is essential. *The Garlock Packing Company.*

Circle number (82) on reply card.

Designed for Big Trenching Jobs

Designed especially for pipeliners who must handle cross-country and other big trenching jobs, the Parsons 420 "Trencher-liner" is now in production. The Model 420 digs trenches 7½ ft deep and 36 to 52 in. wide, and has a multiplicity of digging speeds ranging from 15 to 25 ft per min. Double-action hydraulic rams actuate the wheel for roading and grading. *Parsons Company.*

Circle number (83) on reply card.

Pipeline Gathering Pumps

New electric motor driven pumps for pipeline gathering service are complete assemblies with capacities from 43 to 48 bbl per hr at from 300 to 500 psi, using 220/440-v, 3-phase, 60-cycle motors of splash-proof, vermin-proof construction, operating at 1140 rpm. Pumps are rotary geared type with heat-treated alloy steel gears and shafts, anti-friction bearings, and self-balancing mechanical seals. *Brown & Sharpe Manufacturing Company.*

Circle number (84) on reply card.

Phase Multilock System For Digital-Channelizing

A multi-channel digital data transmission system designed to facilitate point-to-point communication of multi-channel binary signals by radio, wire or teletype have been developed. The Phase Multilock System is said to represent a considerable advance over the conventional frequency-shift keying method, since it is dependent for signal sequencing on phase position, rather than frequency channelizing, resulting in substantial reduction in noise interference and band-widths necessary for communication. *Robertshaw-Fulton Controls Company.*

Circle number (85) on reply card.

Portable Frequency Meter For Servicing Transmitters

The transistorized Du Mont Type 5890-B portable frequency meter, which,

the manufacturer points out, is the first such unit for use with land-mobile communications equipment designed to latest FCC split channel specifications as well as adjacent channel requirements, is capable of servicing and maintaining multiple transmitter installations operating on from 1 to 24 channels in the 25 to 470 mc communications spectrum. With a built-in thermometer, the crystal controlled instrument, with stability at ± 0.00025 percent, makes it possible to bring the accuracy of a laboratory bench instrument to field communications equipment. *Allen B. Du Mont Laboratories, Inc.*

Circle number (86) on reply card.

Excavator Made Mobile

A carrier has been designed and built by Crane Carrier to give mobility to the Samson multiple-purpose excavator, Model FS-1, manufactured by Avery Tractor, Inc. The excavator, which is fully-hydraulic and fullswing to operate in the tightest positions, can be used as a backhoe, shovel, crane, clamshell, grader, grapple, and magnet. The carrier meets its mobility requirements. *Crane Carrier Corporation.*

Circle number (87) on reply card.

Dial Thermometer Line Announced

A completely redesigned line of indicating dial thermometers for measuring temperatures in the range of minus 350 F to plus 1000 F is announced. The new line of "Supertherm" dial thermometers is complete in variations offered as to: Remote or direct reading types; methods of ambient temperature compensation, where required; filling mediums for different temperature ranges and uses; case sizes, materials and styles; and thermometer bulbs of different sizes, shapes, and materials to suit application needs. A broad field of applications, where simple yet accurate indication of temperature is required, is anticipated. *United States Gauge.*

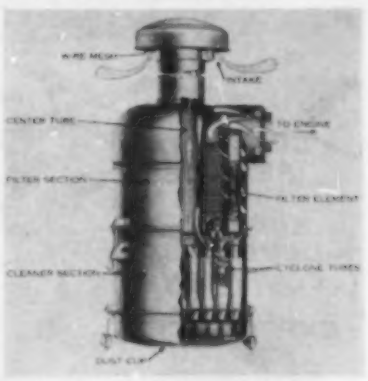
Circle number (88) on reply card.

Turbopower Unit With 360 hp

The Detroit Diesel Engine Division of General Motors has developed a new engine, a Series 110 model, in which a 20 percent gain in horsepower is attained through turbocharging with no appreciable increase in bulk, weight, or fuel consumption. The 360-hp diesel is available with base and radiator as well as a fan-to-flywheel unit. It has been developed for contractors' equipment and other portable and stationary industrial applications requiring a comparatively small, lightweight unit of high power output. *Detroit Diesel Engine Division.*

Circle number (89) on reply card.

Dry Type Air Cleaner



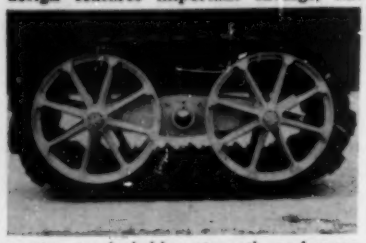
A disposable resin impregnated cellulose filter, multi-cyclone precleaner, aluminum center tube, housing and collecting tray make up this new dry type air cleaner, which has been developed for use on Cat DW20 and DW21 tractors. Tested on such applications as land clearing, construction and logging, the cleaner removes 99.8 percent of all dirt from the diesel's intake air and is effective at any engine speed. *Caterpillar Tractor Company.*

Circle number (90) on reply card.

New Equipment

Trac-Wheels Enter Market

A new product, Trac-Wheels, has been announced by M. J. Crose Manufacturing Company, Inc. This new simplified track design features important savings, has



greater track bridge strength and wear resistance, and a one-point lubrication system. It has been field proved by rugged usage on pipe coating kettles and pipe bending machines. It is pointed out that a set of Trac-Wheels can be easily installed in about 30 minutes. *M. J. Crose Manufacturing Company, Inc.*

Circle number (91) on reply card.

Slide Selector For Gages, Valves

A new Slide Selector for easy selection of the correct size and type of liquid level gages and valves for any job has been announced. Pocket size, it condenses a wealth of specifications, sizes and other data in easy-to-use form. Engineers, designers and specifiers will be especially interested in it. *Jerguson Gage & Valve Company.*

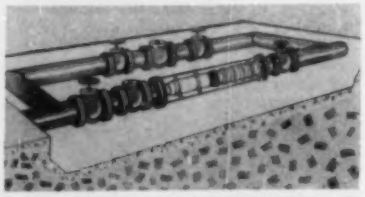
Circle number (92) on reply card.

Tractor Offers Improved Power

The new International TD-15 medium-size diesel crawler tractor, on which production has been announced, is capable of developing 105 hp by its 6-cylinder engine. The engine features positive valve rotators, pressure-lubricated rocker arm shaft, aluminum alloy pistons, fully counter-balanced crankshaft, twin plunger IH injection system, and, like all other International crawler tractor diesels, has all-weather, push-button, gasoline-conversion starting. *International Harvester Company.*

Circle number (93) on reply card.

Submersible Pump



This new submersible pipeline booster pump's design enables it to be suspended within a special section of the pipeline. The section is flanged at each end and becomes an integral section of the pipeline. Named the "Power-Line," the new horizontal submersible is available in sizes designed to operate within pipe from 8 to 24 in. and will give capacities from 100 to 4000 gal per min in heads ranging from 50 to 500. *Layne & Bowler Pump Company.*

Circle number (94) on reply card.

Light, Slow Speed Rotary Compressor

A light, slow-speed rotary portable air compressor — rated at 125 cu ft per min of free air compressed to 100 psi — has been introduced. It is the Le Roi 125RG2

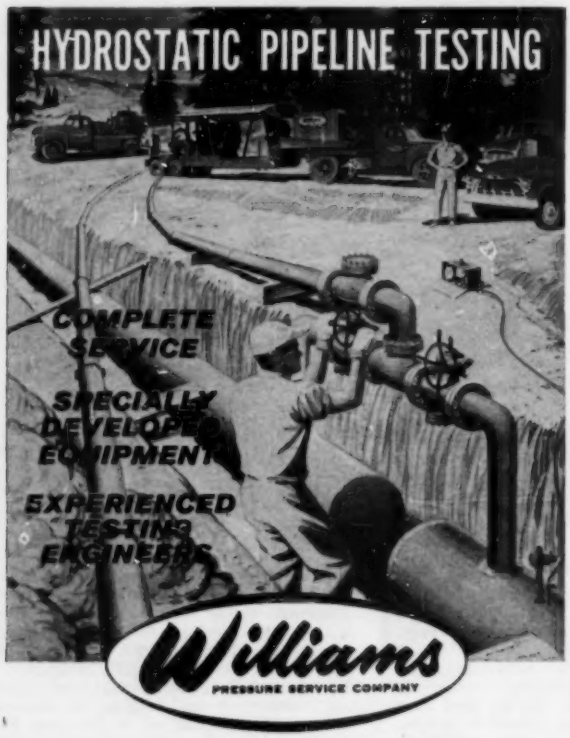
— a sliding vane type 2-stage compressor with an in-line cylinder arrangement — weighing 2250 lb and operating at a speed of 1600 rpm. *Le Roi Division.*

Circle number (95) on reply card.

Transformer-Type Welder

"Budget 500" is a new a-c transformer-type arc welder that is rated 500 amp, at 40 v, on 60 percent duty cycle, with a welding range of 100 to 625 amp in three overlapping main step settings of 100 to 300 amp, 195 to 475 amp, and 375 to 625 amp. These three coarse adjustment steps, with rheostat for fine adjustment, provide dual control to permit choice of open circuit voltage to suit the job at hand. *Hobart Brothers Company.*

Circle number (96) on reply card.



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Extinguishers Improved

A new family of dry chemical fire extinguishers feature "fresh-fill" performance including maximum fluidization without inverting, absolute gas tightness which helps them retain 97 percent of their effectiveness more than a week after pressurization, and simpler operation. The four "D" models are available in fire equipment red or in white for maximum visibility in any location. *Ansul Chemical Company.*

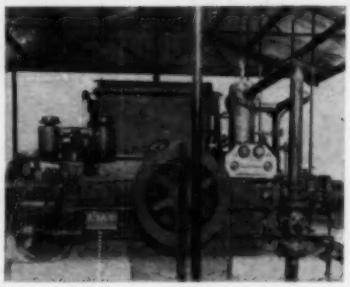
Circle number (97) on reply card.

Iron Powder Electrode

A new low hydrogen, iron powder electrode has been announced to reduce the cost and provide easier operation in welding 12-14 percent manganese steels. It is used with both a-c and d-c welding machines and is available in 5/32-in., 3/16-in., and ¼-in. sizes. Each ¼-in. electrode will cover 9 sq in. with a deposit ⅛-in. thick. *The Lincoln Electric Company.*

Circle number (98) on reply card.

Compressors to Meet Gas Gathering Demands



Highlighting the many design and construction innovations built into the new DPC-230 compressor —the first of a new line of horizontal, opposed-cylinder gas engine-compressors released by Ajax Iron Works—is the massive four-throw crankshaft, mounted on three double-row tapered roller main bearings, having engine throws of greater length than for the compressor side. The arrangement permits piston speeds for optimum efficiency of the compressor while obtaining maximum power and fuel economy from the power side. *Ajax Iron Works.*

Circle number (99) on reply card.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW PIPELINE LITERATURE

Valve-Regulator Maintenance Manual

Complete installation, operation and maintenance instructions for Rockwell-Nordstrom valve-regulators are described in a new 16-page photo-illustrated manual. In addition to the illustration of typical installations, mounting arrangements and piping arrangements, the manual also includes line, cutaway and schematic drawings and characteristic curves for the valve positioner, and special sections devoted to: Typical operational troubles, how to check troubles, orifice and nozzle cleaning, how the positioner and controller works, and adjustments. *Rockwell Manufacturing Company.*

Circle number (101) on reply card.

Electronics Buying Guide

The 1959 general catalog of Allied Radio Corporation lists in 452 pages over 32,000 items. This new electronics buying guide places special emphasis on equipment for industrial maintenance, research and production requirements and includes special sections on public address equipment and recording equipment, and lists "3-dimensional" stereophonic sound equipment and the Allied Knight-Kit line. *Allied Radio Corp.*

Circle number (102) on reply card.

Flowmeter With Magnetic Indicator

Technical flyer 10A1247 gives specifications on the Magnasight Indicating Flowrator Meter, an all-metal reduced accuracy variable-area flowmeter with a magnetically coupled indicator used for high pressure, high temperature service. Available in 5 sizes, the ¾-in. or 1-in. size is rated for operation to 500 psi at 500 F. *Fischer & Porter Company.*

Circle number (103) on reply card.

Tandem Welding

Multiple electrode submerged arc tandem welding, which employs 2 or more separate arcs operating in close proximity, one behind the other, on the same weld bead, is described in detail in the new Lincoln Bulletin 5200.2. Information on the application opportunities and requirements with tandem welding, and commonly used equipment arrangements are presented. *The Lincoln Electric Co.*

Circle number (104) on reply card.

Gas Engines for Packaged Compressors

Two new bulletins detail compressor service applications for Superior high compression gas engines (200 to 700 hp). Bulletin 119 contains features, specifications, dimensions, rating curves, and optional power take-off data on the Superior 6G-510 engine, including illustrations of the block, helical gear drive system, new components, and the 6G-510 in action. Bulletin 120 provides the same information and similar photographs on the Superior 6 and 8-cylinder G-825 series. Both folders stress performance characteristics. *White Diesel Engine Division, The White Motor Company.*

Circle number (105) on reply card.

Quoted from Mr. Dillard Stokes' Column, Shreveport Journal, Oct 13, 1958..
"President Washington, who spoke of usurpation, said in his Farwell Address: 'If in the opinion of the people, the distribution of the Constitional powers be in any particular wrong, let it be corrected by an amendment . . . but let there be no change by usurpation; for . . . this is the customary weapon by which free governments are destroyed'."

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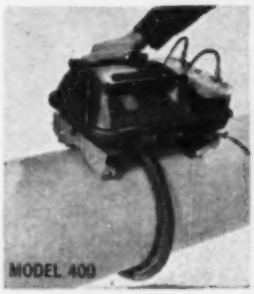

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New Literature

Bulk Handling Pumps

Three basic lines of rotary pumps for bulk handling of petroleum products, synthetic solvents and many industrial liquids are described in a new Bulletin 100. Included is a table showing capacity ranges of the various models when handling basic types of liquids. Other tables and data are furnished to help select the pump model, pump speed, motor size and motor speed to satisfy the intake and discharge conditions of a given application. Several mounting styles and drive units, as well as cutaway photographs that show the pump's interior compartments, also are included. *Blackmer Pump Company.*

Circle number (106) on reply card.

Recorders Described

Latest descriptive information on General Electric's new type HF single-point and HG multi-point strip-chart recorders and recording controllers is provided in Bulletin GEA-6792. The 12-page publication also provides information on type HE round-chart recorder, recording controller, and circular scale indicator, type HF precision indicator, and control forms, giving features, application data and specifications, outline and mounting dimensions and photographs of all equipment. *General Electric Company.*

Circle number (107) on reply card.

New Features for Tractors

Highlighting a 2-color broadside on the Caterpillar DW21 (Series D) and DW20 (Series F) wheel tractors are 2 new features of these machines — the Super Turbo Engine and Torsionflex Seat. A detailed explanation of the Pressure Ratio Control system of air induction also is included and graphically shown in a schematic diagram. In addition, information also is included on the No. 456 and No. 470 Scrapers and how their operating abilities are matched to the new wheel tractors. *Caterpillar Tractor Company.*

Circle number (108) on reply card.

Regulator Repair Data

Illustrated bulletin gives step-by-step instructions for installation of new seats in welding and industrial regulators in order to reduce repair charges and downtime. Prepared especially for welding foremen and plant maintenance foremen. *Modern Engineering Company.*

Circle number (109) on reply card.

Cranes Detailed

The complete range of Koehring rubber mounted cranes, from 15 to 45 tons lift capacity, is presented in a new 4-page, 2-color bulletin. The mobile equipment is illustrated, with commentary on each size crane. *Koehring Division, Koehring Company.*

Circle number (110) on reply card.

Flow Switch Folder

A line of flow switches—devices that respond to flow of liquid in a pipeline to make or break an electrical circuit—is described in Bulletin FS-1. As listed in this bulletin, the flow switches have an extremely wide range of application. They can be used to light signals, sound alarms, start or stop motors, burners or metering devices. The bulletin introduces the new FS4 Series flow switches, suitable for pressures up to 100 psi, and covers the E-2 Series, a completely waterproof design suitable for pressures up to 150 psi. *McDonnell & Miller, Incorporated.*

Circle number (111) on reply card.

High Speed Generators

Bulletin 2100-PRD-250 describes a line of standard, high speed generators which are available from 3.75 through 62.5 kva, 60 or 50 cycle, single or 3-phase, in all standard voltages below 600-v, single or 2-bearing. *Electric Machinery Manufacturing Company.*

Circle number (112) on reply card.

New Weed Killer Needs No Mixing

Ureabor meets the weed problems on pipeline rights-of-way and along fences at stations. A scientifically balanced combination of borates and substituted urea, this weed killer is ready to use dry — there is nothing to mix and no need to haul water. Ureabor is described in Service Bulletin 15W. *United States Borax & Chemical Corporation.*

Circle number (113) on reply card.

Silencers Explained

How air-jacketed silencers suppress engine noise while they ventilate engine room and surrounding areas is told in an illustrated, 4-page brochure. Included are descriptions, dimensions, and applications of 9 models. *Emhart Manufacturing Company, The Maxim Silencer Company Subsidiary.*

Circle number (114) on reply card.

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CRC JOINT WRAPPERS

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New Literature

Pipe Handling Study

A recent case study from the Hyster Materials Handling Information Service shows straddle carriers with special straddle grapple attachment handling pipe in Venezuela. The problem, solution and results are presented in this illustrated report. *Hyster Company.*

Circle number (115) on reply card.

Telemetering System

Specification S301-1 gives full details on Honeywell's new high speed tubeless frequency telemetering system for long distance data transmission. The system is particularly applicable to the power generation field but will transmit any variable that can be converted to an electrical signal. *Minneapolis-Honeywell Regulator Company.*

Circle number (116) on reply card.

Data On Motors, Controls Given

A completely illustrated 27-page booklet, "Synchronous Motors and Controls," contains motor selector charts, application data, and formulas for calculating power factor. The booklet presents a quick summary of types and features of motors and controls. The material includes a discussion of power factor correction, factors to consider in selecting the motor, and special application problems. *Westinghouse Electric Corporation.*

Circle number (117) on reply card.

Rotameters for Measurement

Bypass Rotameters for measuring fluid rate of flow in pipelines 2 in. in diameter and larger are described in Bulletin 18B. The Rotameters are applicable to both liquids and gases. A complete installation, and what it comprises, is described. Presented also are simplified, easy-to-follow instructions for determining the permanent pressure loss across the main orifice, and the required straight run of pipe before and after the main orifice. *Schutte and Koerting Company.*

Circle number (118) on reply card.

Antenna Gain Chart

A set of antenna gain charts help the engineer determine the antenna and cable sizes needed to achieve the required gain with Prodelin Incorporated's complete microwave antenna systems. These prepackaged systems feature the newly developed semi-flexible Spir-O-Line coaxial cable with a choice of diameter spun aluminum parabolic antennas or aluminum mesh antennas of varying sizes. The systems include all the hardware needed for assembly, and selection of frequency bands. *Prodelin Incorporated.*

Circle number (119) on reply card.

LACT Systems Chart

A chart of automatic custody transfer systems has been made available. It is called "Automatic Custody Transfer Pottermeter." This chart acquaints the reader with the Pottermeter system of measurement, the volumetric tank system, the weir tank measurement, and positive displacement metering. *Pottermeter Company.*

Circle number (120) on reply card.

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Two men can cover a pipe section with KAPCO ROCK SHIELD in only 2 or 3 minutes. Compared to the man-and-equipment-hours required for the old-fashioned dirt-padding method of pipe protection, KAPCO'S *economy* and *effectiveness* are self-evident.

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Canadian News Notes . . .

New System Serves 33 Ontario Communities

Northern Ontario Natural Gas Company's extensive system of laterals and local distribution lines in northern and northwestern Ontario has been completed, and turn-on ceremonies have been held in most of the 33 communities being served. The company laid out capital investment of about $15,000,000 this year to build systems in 31 communities between Kenora in northwestern Ontario and Orillia, a few dozen miles north of Toronto.

The beginning of service to these communities marks the largest single construction season for local distribution systems in Canadian pipelining history, although the total pipeline mileage is much less than the record laid by Inland Natural Gas Company last year in the interior of British Columbia, because Northern Ontario Gas is taking off all its supplies from the Trans-Canada main line. The two principal laterals have been completed, a 32-mile line to Timmins, and 88 miles of 10-in. to Sudbury.

Union Gas of Canada Completes Two Laterals

Union Gas Company of Canada, Ltd., has completed two laterals in its southwestern territory of Ontario, in the vicinity of Georgian Bay on Lake Huron. Local turn-on ceremonies have been held in the six towns to which gas service has begun.

The larger project is a 45-mile 8-in. line from Stratford to Goderich, providing service for Goderich, Clinton, Seaforth, and Mitchell. The smaller job is an 11-mile 8-in. lateral to the south that serves Amherstburg and La Salle.

Trans Mountain Traffic Has Declined Steadily This Year

Throughput in the Trans Mountain Oil Pipe Line Company system has been declining steadily this year, although the rate of decline compared to the same month of 1957 has been diminishing. Average deliveries in the first nine months of 1958 were 84,635 bbl per day, not quite half the volume of 174,204 bbl per day in the same period of 1957.

First quarter deliveries averaged 102,180 bbl per day, with second and third quarters 78,528 and 73,512 bbl per day, respectively. The fourth quarter is estimated at around 65,000 bbl per day, on the basis of refiners' nominations for October and November by the refineries on the line.

New System Now Delivering Gas From Pembina Field

Deliveries of natural gas are now being made from the Pembina oil field to the Edmonton city distribution system of Northwestern Utilities, Ltd. The associated gas is gathered through an extensive field system operated by Goliad, Ltd. Gas from more than 2000 wells, formerly flared, are being delivered initially at the rate of 50,000,000 cu ft per day, through a 70-mile 16-in. main line.

Gas is purchased in the field by Alberta and Southern Gas Company, Ltd., and delivered to Northwestern at the eastern edge of the field. Unitized facilities serving 70 individual producers make up the gathering system and processing plants, and the total investment is about $25,000,000. The entire project was stimulated by a provincial conservation board order prohibiting further field flaring of casinghead gas and making a conservation plan compulsory.

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